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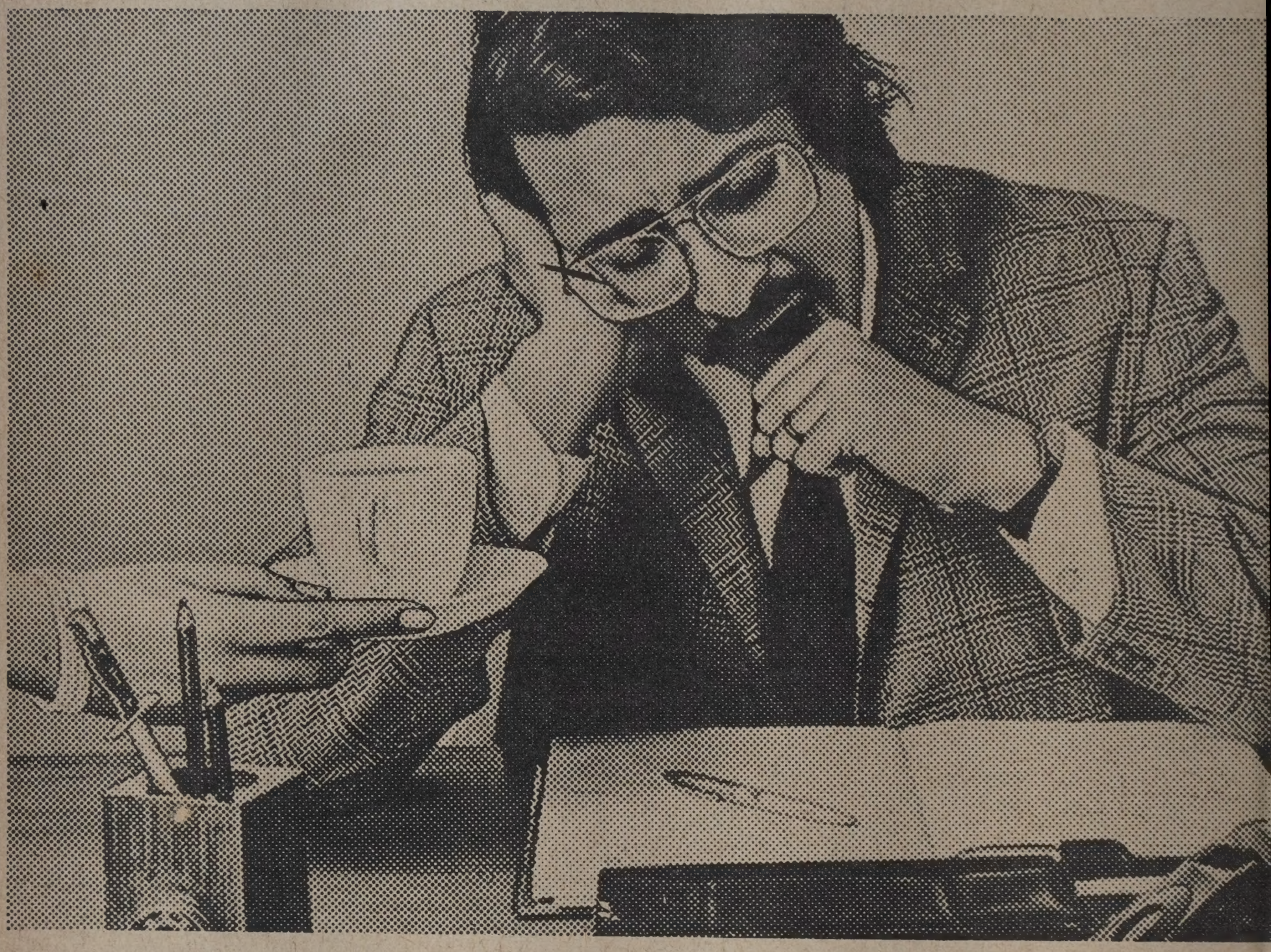

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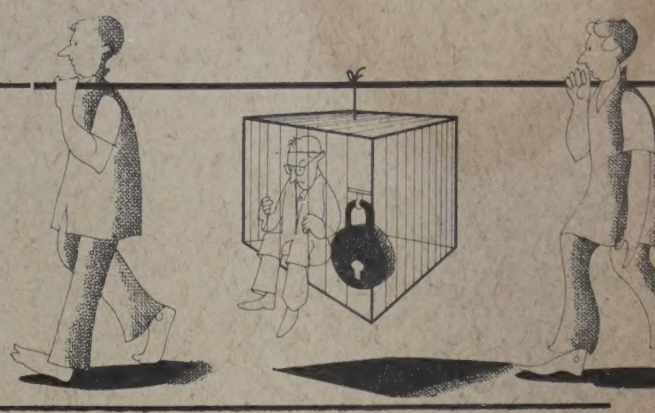

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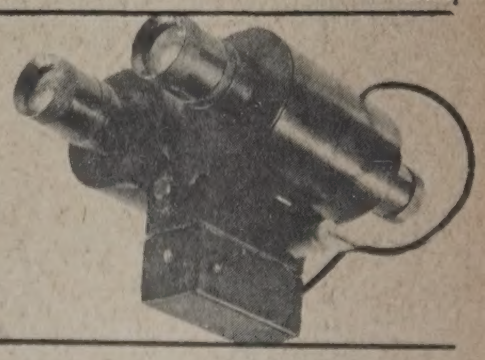

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SURENDR JHA

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Science Policy: Let's Start the Debate

ASKED to comment on the science policy of the present government, a well-known scientist reacted sharply. "What?" he said, "Do you want me to get the sack? You know I am a government employee, and the code of conduct for government servants is very clear on the subject of its employee expressing his views publicly."

Apparently, the Prime Minister, too, had the same code in mind when he addressed the members of the reconstituted National Committee on Science and Technology in New Delhi last September. Almost his very first sentences were: "We have nominated a scientist, a person outside government, as Chairman. We have also taken more members from outside governmental organisations. This has been done to ensure that we get independent and objective advice."

This is just as well. But, with over 90 per cent of this country's scientific activities controlled directly by the central and state governments, how much of such free and unbiased advice will be forthcoming? And from where? From scientists employed in the universities? In private firms? They are too few and years of subservience to administration have made them too docile.

To help the Prime Minister and his government, SCIENCE TODAY has decided to have an informed public debate on this country's science policy and its plan priorities. We are presenting below the text of the inaugural address by the Prime Minister, and on page 13, the Anniversary Address given by the President of the Indian National Science Academy at Ahmedabad. We hope to follow it up with similar articles in the coming months.

India, let us not forget, is on the threshold of a great change. Consider:

- India, in numbers, ranks third in the world in trained scientific and technological manpower and is said to be the eleventh most industrialised country in the world.
- Both in manpower and industrial infrastructure, India seems to have reached a critical stage of take-off, to build an entirely self-reliant economy.
- Indian technology, as it is being developed in recent years, is beginning to be not only appropriate for its own economic and social development, but also relevant to the needs of most of the Third World countries.

It would thus appear that what India lacks now is a set of clearly defined priorities and a fierce political will to pursue them. And we believe such a set of priorities and the will can emerge only from an extensive national debate.

S.J.

● The present committee marks some departure from the earlier committees in several ways. First, about the composition. We have nominated a scientist, a person from outside government, as Chairman. We have also taken more members from outside governmental organisations. This has been done to ensure that we get independent and objective advice.

Second, about the terms of reference. The NCST is to function as the principal scientific advisory body to the Government. The primary role of the new NCST is to help in formulating and implementing government policies on science and technology, for ensuring that the people of the country derive the maximum possible benefit that can accrue from science and technology. Since science and technology are expected to accelerate the speed of national development, we should get, in the long run, better returns from our investments in connected fields. The pursuit of science in a developing country striving hard to become self-sufficient, and facing the task of providing minimum basic needs of the poorer section of the people, cannot be as altruistic as in the developed countries. Science must become something we live with, we work with, something which makes an increasingly worthwhile contribution to the common weal. Science must provide a new philosophy for action, enabling man, irrespective of origin, to rise to his full stature.

The benefits from science have mostly accrued to the upper echelons of society even as the returns from development have gone largely to the better developed nations. The enhancement of quality of life of the people, and the fulfilment of their basic needs, are some of the very important problems which the NCST will have to consider. The NCST can *suo motto* take up for consideration any matter which may help to promote scientific and technical activity in the country and to create a better climate for science.

Government attaches the greatest importance to the development and application of science and technology in the country. No area of science and technology in India should be considered as excluded from the purview of NCST. The scientific and technological efforts have to be viewed in their entirety. The tendency to treat certain areas as exclusive preserves of certain individuals or groups is not desirable. The NCST, which includes representatives of most of the major scientific agencies and departments, should take a total view of the situation.

The need for forging appropriate links between our scientific institutions and the user organisations has been emphasised from time to time. Most of our laboratories and research organisations are objective oriented. They are expected to contribute to the best utilisation of our resources, and the betterment of the people.

This will be possible only through a determined effort in the field of applied science. A new direction has to be given to our scientific effort. Emphasis has to be laid more on the application of knowledge than merely on its creation. The applied scientists, and the technicians, have to be given their proper place in our research and development effort.

At a meeting of the directors of national laboratories which I had occasion to attend about a couple of months ago, the major complaint was that the results of their research were not being utilised adequately. It has also been reported that some of the Ministries have, in disregard of the work of the laboratories, gone in for foreign collaboration. Some of the Ministries have set up their own R & D establishments in areas in which government laboratories are functioning. There has to be proper coordination of efforts, and avoidable duplication has to be checked. The proposed reorganisation of the CSIR is a step in this direction.

There is no intention of taking away any autonomy. It is our intention to make the autonomy more meaningful. We should not forget that the scientists drew their sustenance from the people of this country. The laboratories must be responsive to the needs of the people and become more responsible in their functioning.

Our performance, in the ultimate analysis, will be judged by the impact we make on the lives of the people. We have to ensure speedy application of known knowledge to day-to-day problems affecting the lives of our people in the villages. Simple science, simple machines, and simple techniques, used imaginatively can lead to considerable progress.

I would like the NCST to give expeditious consideration to the question of fixing priorities so that our scientific efforts gather momentum in proper direction and the benefits accrue to those in the greatest need.

— Mr. Morarji Desai on 29 September 1977

Anti-amoebic combinations — a right perspective

Dr. P. C. Dandiya, Dr. S. K. Patni and Dr. J. K. Bapna have criticised several of the anti-amoebic pharmaceutical products available in the market in "Anti-amoebic combinations : are they therapeutically sound ?" ('Letters', August 1977) on the grounds of : (1) low dosage of tetracycline, which they classified as sub-therapeutic, (2) such low doses are not only ineffective but positively harmful as they are likely to cause resistance in the micro-organisms, and (3) oxytetracycline is better than tetracycline.

To evaluate the justification of the first two points, one has to go through the works of such eminent men as S. J. Powell, A. J. Wilmot, and R. Elsdon Dew who have done extensive work in the treatment of amoebiasis as reported in *Lancet*, 9 January, 1960, p. 70 ("Potentiating effect of quinoline on the action of tetracycline in amoebic dysentery"). The inclusion of a daily dose of 150 mgm of tetracycline in a combination of di-iodohydroxyquinoline and chloroquine boosted the cure rate to 94 per cent against 60 per cent, 48 per cent, and 20 per cent for treatment with di-iodohydroxyquinoline and tetracycline, tetracycline and chloroquine, and di-iodohydroxyquinoline and chloroquine, respectively. Again, T. G. Armstrong, Wilmot and Elsdon, in their article "Antibiotic residues in amoebiasis" (*Lancet*, 2-14, 1955) have stated that " very small doses of 100 mgm daily of tetracycline are effective in acute amoebic dysentery and can be rendered highly efficacious by the addition of chloroquine and di-iodohydroxyquinoline."

In view of these facts, we have included 25 mgm of tetracycline per tablet in our product, Amicline tablets, giving a total daily dose of 150 mg. Clinical reports on our product have shown a complete cure rate of 90 to 95 per cent ; it has also been found to be comparatively safe, with least side-effects.

Evidently, there is no need to give a high dose of tetracycline in amoebiasis treatment, particularly when combined with di-iodohydroxyquinoline and chloroquine phosphate. It has been reported (Ref. *Martindale*, 27th ed, p. 1188) that a daily dose of 1gm tetracycline has caused resistance in faecal *E. coli* in all patients after four to seven days of treatment.

In 1972, we had taken up this matter with Dr. Powell, who wrote to us that they had never come across any case of antibiotic resistance with small doses of tetracycline. On the other hand, it has been reported that larger doses of tetracycline cause : (1) depopulation of the intestinal flora resulting in the proliferation of resistant variants of Staphylococci, *E. coli* and Enterococci. (Ref. *Gazette Medicale de France*, 10 December, 1964), (2) avitaminosis, nausea and vomiting, (3) diarrhoea (Ref. *British Medical Journal*, 1968, pp. 402-403), and (4) amoebicide (Powel, Wilmot and Elsdon, in their article referred to earlier, have reported a cure rate of 92 to 97 per cent with 1 gm daily dose of tetracycline, but the relapse rate was quite significant).

There is no reason for highlighting the superiority of oxytetracycline over tetracycline ; references point to the contrary. ("Toxic and irritative effects", *The Pharmacological Basis of Therapeutics*, Goodman and Gilman, 3rd ed, p. 1249). It has been reported that oxytetracycline causes more intensive side-reactions than other tetracyclines. For instance, " epigastric burning and distress, abdominal discomfort, nausea and vomiting may occur. Oxytetracycline produces these manifestations more frequently ; less irritating are chlorotetracycline, tetracycline . . . ."

From this we can conclude that : (1) small doses of tetracycline along with other amoebicides are effective in the treatment of amoebiasis, (2) higher doses of tetracycline cause side-effects including diarrhoea, avitaminosis, etc, (3) antibiotic-resistant bacteria are formed with a daily dose of 1 gm of tetracycline, (4) oxytetracycline is in no way superior to other tetracyclines, and it has been reported to have intensive side-reactions, and (5) there is no need to give di-iodohydroxyquinoline if 1 gm dose of tetracycline is given ; such a dose of antibiotic alone is amoebicidal.

R. C. AGGARWAL
Works Manager
Griffon Laboratories Pvt Ltd
20, Haines Road, Bombay 400 011

Drs. Dandiya, Bapna and Patni write :
Mr. R. C. Aggarwal defends the relevance of the composition of his company's product tablet Amicline which contains tetracycline 25 mg along with two other amoebicidal drugs. He has advocated the use of tetracycline in a daily dose of 150 mg along with other amoebicidal drugs, on the assumption that larger doses of this antibiotic cause depopulation of intestinal flora and some other minor adverse effects. As a matter of fact, one of the main reasons for the use of antibiotics in amoebiasis therapy is their depopulation action on the intestinal flora on which amoebae survive. Once this is achieved, the anti-amoebic drugs achieve their goal faster. The adverse effect of depopulation of flora assumed by the reader is in fact the most important desirable therapeutic effect. The reference to the paper of Powell *et al.* (*Lancet*, 1, 76-80, 1960) needs a careful consideration.

The relevant para in the paper reads : " When tetracycline 1 g daily dose was given for 10 days the rectal ulcers were healed in 89 per cent of patients by the 10th day and in 94 per cent by the 15th day. By contrast, when tetracycline 150 mg daily was given with diodohydroxyquinoline and chloroquine, the ulcers were healed in only 24 per cent of patients by the 10th day and in 62 per cent by the 15th day. Thus, when tetracycline is used in small doses the rate of healing ulcers is considerably slower, although the end result is satisfactory. In view of the slower clinical response and less rapid healing of ulcers, tetracycline in small doses is not recommended in acute amoebic dysentery ".

It is thus clear that the healing rate is slower if the combination does not provide a daily dose of 1 g of the antibiotic.

Contrary to Mr. Aggarwal's claims, the *Extra Pharmacopoeia Martindale* (27th ed., p. 1188) at no place states that 150 mg dose of tetracyclines decreases the chances of resistant strains of *E. coli*. It appears that the reader is completely unaware of the fundamental principles of chemotherapeutics. He should refer to *Pharmacological Basis of Therapeutics* by Goodman and Gilman to know that subtherapeutic dose is one of the most important causes of the development of resistance to antibiotics. Another basic concept about which the reader is not aware is that an agent less absorbed in the intestines will have a better and longer action than the one well absorbed. Of all the tetracyclines, oxytetracycline is the poorest absorbed, and is, hence, regarded as a superior agent for action in the intestines. The reader is referred to *Pharmacologic Principles of Medical Practice* by Krantz and Carr (1969) and *Antibiotic Therapy* by M. L. Gujral to have a clearer picture about the superiority of oxytetracycline and other antibiotics in the treatment of amoebiasis.

Aero-charger for cars

Let me say a little about the aero-charger ("Bicycle without a dynamo", Ideas & Inventions, September 1977). Miss N. K. Rohini, a chemistry graduate of Calicut University, won an award for her essay on an electric car drive in the NRDC Invention Essay Contest for seniors in 1975-76. According to her, an aero-charger charges the weak cells, while the car is driven with a live cell ; an automatic circuit exchange changes the terminals to the weak cell as the cell gets charged. The aero-generator is driven with the head-pressure of the car's front. The car will not require recharging. For lack of funds, she had to leave the idea on paper.

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Kanchira Mukku P.O.
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Fuel-saving devices

Being keenly interested in fuel-saving devices, I would like to add this to R. L. Sharma's " Saving fuel on downhill drive " (Ideas & Inventions, April 1977). On a downhill drive, the engine must be kept running. The slow-speed circuit of the carburettor is used while coasting when the accelerator pressure is released. It is uncontrollable and risky to disengage the gears while coasting for saving on fuel. Professional drivers always use the same

gear on uphill and downhill drives. Freewheeling is used on level driving for a critical-speed. Mr. Sharma's effort is appreciable, but it has some limits. It must be automatically operated.

Hydrogen and oxygen can be used for saving fuel after water analysis. I have tried it myself. According to available information, 4 per cent hydrogen is sufficient. The wastage heat of the exhaust gas can be used to create a continuous limited steam to increase the vapour content of the incoming air for the petrol engine. For diesel engines, an oxygen and cold air supplying unit can be used to get complete combustion. It is common experience that the engine runs smoothly and more efficiently at night. Instead of diverting the petrol supply of the carburettor and taking the additional risks, it is better to supply more air by an additional unit, operated on engine vacuum and hydraulic pressure. At idle and slow speed, the vacuum valve will not let any filtered air into the chamber and, at the same time, the low oil pressure will close the valve. It will also not allow the filtered air to the additional flange, which will be fitted beneath the carburettor base. But it will work only on high vacuum and high oil pressure. This unit will save petrol automatically. Of course, on downhill drives, it will leak off high vacuum and affect petrol suction from the carburettor. In the case of diesel engines, fuel can be cut off by high oil pressure on a downhill drive. But this needs some alteration in the above unit for diesel engines.

Y. S. KAREVALE
833 A, Goreram Lane, Nasik

The " deadly midgets "

The boxed-item " Deadly midgets," (June 1977, p. 53) mentions that " spiders can be dangerously venomous, though there are no dangerous species in India ". I may refer to Price's *Textbook of the Practice of Medicine* (ed, Scott, R. B., 11th edition, 1973, p. 304). It says that in Assam, tea pickers are usually stung by spiders, said to be *Chilobrachys*, on the backs of the hands or fingers. This leads to " extensive coagulation and consequent blocking of circulation occurs, resulting in loss of the affected digit ".

NARENDRA BHADRA
Medical College, Calcutta

Cattle-breeding—need for a clear objective

Dr. Anil Sadgopal and Mr. Rex D'Rozario have raised some pertinent points (" Does cattle-breeding help the rural poor? ", August 1977) about the role of cattle-breeding, but they have not kept the totality of the picture in view. I agree that in most of the development programmes, it is the so-called rural elite who first derived the benefits, that technologies available are not properly selected and utilised, and that the services required by the beneficiaries, particularly the poorer sections, are not made available in a comprehensive manner. The reasons for these drawbacks are known, and the blame doesn't lie with the Government alone. Organisations like the Kishore Bharati, the BAIF (Bharatiya Agro-Industrial Foundation) and others who are conscious of these pitfalls, should try to implement the project such that these drawbacks are taken care of.

Is it enough to realise the drawbacks and criticise some of the projects? Most of the people who have some experience with rural agricultural development projects would realise how difficult it is to implement the programmes in an ideal manner; nevertheless, one has to try.

About the main theme of the article, unlike other attempts to provide gainful rural employment which need considerable initial investment and training (smallscale industry or looms, leather tanning, etc), cattle-breeding is accepted by the rural poor, and it needs little initial investment; in most agriculturally backward areas, people have been relying on animals, mostly cattle, sheep or goats, as their major source of income. Given the right type of milch cow, income from the improved breeds would be the highest compared to any other trades that can be made available to the villagers (this is what the economists tell us). Efforts to make the farmers buy crossbred cattle, which needs a high investment, should be discouraged.

With regard to technology, it may be said that in the past, vital veterinary services were not satisfactory and that the milk processing and marketing industry was totally in the hands of the private sector, who reaped the maximum benefits. However, a lot has been done to overcome these limitations in the last few years. The only shortfall has been the paucity of the vaccine for the foot-and-mouth disease. This, too, will be freely available within a year or two. Co-operatives ensure a fair price for milk to farmers throughout the year. Much, of course, needs to be done to make technical assistance and guidance available to villagers. And if the programme is properly planned and trained personnel are posted at the centres, it is not difficult to get good results.

It is a myth that crossbreds need large quantities of green fodder. The BAIF has shown that crossbreds can produce a fair amount of milk with a limited supply of greens. It is the responsibility of the organisations implementing the development programme to find ways to augment the fodder supply without competing with grain and other crops and also make available low-cost feed. We have come across two fodder varieties which can be successfully grown in fields unsuitable for conventional agriculture. Largescale cultivation of *Leucaena leucocephala* has been undertaken in parts of Maharashtra, Gujarat and UP with encouraging results.

The frozen semen technology has tremendous advantages and is decidedly more economical than using fresh semen under the following conditions: (i) selected bulls of high genetic merit are available, and (ii) such bulls are to be utilised intensively and on a large scale. For progeny-testing of bulls and proper utilisation of proven bulls, there is no alternative to frozen semen. One or two units to manufacture liquid nitrogen containers are likely to be set up in the country. I agree with the suggestion that we should look into the possibilities of exploiting buffaloes, goats and sheep to provide additional income. However, substitution of crossbreds with these animals is out of the question.

Recognising all these factors and taking into account past experiences, it is necessary to take up a strategy of integrated rural development through projects which would provide complete services to the farmers. One need not shirk from adopting advanced technology if it is found appropriate. What we need are, a clear objective, proper planning and a pragmatic approach. But this, I do admit, is easier said than done.

D. V. RANGNEKAR
Project Coordinator
Bharatiya Agro-Industries Foundation
Uruli-Kanchan, Poona District, Maharashtra

Today the trend in dairying is to consider a herd as a single unit. Since such a unit is out of the reach of the rural poor, is it necessary to axe the cross-breeding programme? This is the most efficient system of upgrading our milch cattle within a reasonable period. Buffalo-breeding is handicapped by a limited gene pool within which to bring up a high-producing economic animal; artificial insemination is much cheaper than natural breeding. Goat-breeding for milk cannot immediately succeed since indigenous breeds of goats do not give an economic yield, and breeding with exotic animals will involve some related problems.

Veterinary costs are high at the moment since preventive medicine is not practised at the levels required and can be effectively lowered with the advent of herd health methods as practised in the West. It must be remembered that cattle upgrading is a western technology and we are only adapting it to our needs. The alternative is to collectivise the dairy industry on a co-operative basis into units which are self-contained in all the allied technologies such as feed, semen and milk processing.

AJIT MARU
College of Veterinary Science
A. P. Agricultural University
Rajendranagar

Four colour conjecture

The names of the persons who have proved the " Four Colour Problem " recently are not Apple and Hakin as given in the August (" The four colour conjecture : a post-mortem ", p. 32) and October (Letters, p. 7) issues. They are : K. Appel and W. Haken.

V. KRISHNAMOORTHY
Faculty of Science
Madras Institute of Technology
Madras 600 044

Taking science to the villages

The two articles " Does cattle-breeding help the rural poor? " and "Academic science and technological culture " (August 1977) evoked special interest in me, being a worker of the Kerala Sastra Sahithya Parishad — a voluntary, unofficial, social-education organisation, trying for the past 15 years to propagate science and technology among the masses. The organisation publishes four monthly magazines at different educational levels in Malayalam ; one of these is *Grama Sastra Samithi Bulletin* meant for villagers.

We have come across a variety of instances where well-intentioned rural development programmes sponsored by the Government have either dried up in its executive channels, or gone to benefit the already privileged sections of the society, or have been misused. The common people view these programmes with cynicism, sometimes without reason and often with reason. To educate the masses and their opinion-forming leaders, a few months ago we conducted thousands of study-classes on the physical resources of Kerala in almost all Panchayats. To overcome the problems of applying modern science and technolgy in conditions existing in rural life, a rural technology centre (Grameena Academy) is proposed to be set up in the near future. Authors of these useful articles referred to above and readers who are interested in the ideas expressed in them may please contact me or any other official of the Kerala Sastra Sahithya Parishad and extend their experience and help in our venture also.

K. V. RAGHUNATHAN
State Convenor
Grama Sastra Samithi
(Rural Science Forum)
Kerala Sahithya Parishad
Cannanore-4 (Kerala)

Fantastic claim

I was shocked to find a full-page advertisement in *Science Today* (October 1977) of the " Astro Tele-Response System " which promises instantaneous riches, love, fine possessions, friends, power and secret knowledge, for a modest investment of Rs. 40. Has *Science Today* investigated the soundness of the fantastic claims made by the advertiser? If not, is *Science Today* justified in permitting such an advertisement to be published in the journal, resulting in the exploitation of the gullible public?

A. SRINIVASAN
Personnel Officer
The India Cements Limited
" Dhun Building "
175/1 Mount Road
Madras

If the author of this system has used it to obtain all he has desired, it is preposterous that he should also make some extra petty money by selling his system for Rs. 40. Though it is a common practice now to sell such items to the gullible and simple-minded by VPP, what really pained me was a magazine like *Science Today*, which should strive to extirpate such belief, has housed such an advertisement.

K. SMILES MASCARENHAS
Raman Research Institute
Hebbal P.O.
Bangalore 560 006

It is sheer commercialism to publish such advertisements. Don't give explanations like "the editorial board is not concerned with the business side of a magazine." You have a definite moral responsibility to get it stopped, and please do it.

ASHOK TANKASALA
SASEETHARAN RAJU
009-Kaveri
Jawaharlal Nehru University
New Delhi 110 057

Going downhill on neutral is not illegal

Referring to the two letters on " Going downhill on neutral " (Letters, October 1977), the following information may be useful. In a mountainous terrain, it is usual that the road rises up and down, and this may be exploited in saving considerable quantity of petrol by intelligently manipulating the gear box, engine, clutch and brake pedal. When the vehicle climbs down (only light vehicles), it is not essential to select the same gear as in climbing up, except in the case of heavy transport vehicles. Even in the case of light vehicles, it is easy to select the lower gear (first or second) while going down ; the engine can be disconnected and allowed to idle. The ignition switch should never be switched off, to avoid splashing of engine oil in the plugs. The vehicle gains momentum and the idling engine can be best utilised as an emergency " flexible " brake in addition to braking the vehicle conventionally should the occasion demand. This procedure is not illegal at all ; experience shows that one can obtain 8 km per litre or even more, against the usual rate of 6 km in light vehicles — a petrol saving of about 33 per cent.

S. PUNNAIAH
Executive Engineer
Stores & Transport Division
Donkarai 531110

Not hot, really

The toxicity of pepper against insects (" Pesticide from pepper ", November 1977, p. 13) is known since 1943 when its activity against houseflies was reported by E. K. Harwill, A. Hartzell and J. M. Aurther (contribution for Boyce Thompson Institute, **13**, No. 2, June 1943). The active component of black pepper (*Piper nigrum* L) is piperine, which is more toxic than pyrethrum. It has been shown to kill 75 per cent of flies at 0·1 per cent concentration, against 51·1 per cent by pyrethrum. Dr. Su's report in *Agricultural Research* is, therefore, not new.

B. P. SAXENA
Regional Research Laboratory
Canal Road, Jammu Tawi

Vertical windmill

Though the two buckets at the top of the vertical windmill (October 1977, p. can catch enough wind, the windmill its may be toppled. And for the same reaso the windmill needs good support at the base of the shaft.

KALLOL KANTI KAR
Achipur, Budge-Bu
24 Parganas, W. Ben

Food preservatives

The US Food and Drug Administration proposed that BHT be dropped from the approved list of food additives (" What a we adding to our foods?", August 1977) BHT, which has been an important preservative for a good variety of sweetmeats and other goods for a numbe of years, is now found to be not safe. It was recently reported that the preservativ can cause tumours in animals.

P. C. BHATTACHARY
Vidyasagar Colle
39, Sankar Ghose La
Calcutta 700 0

Why the stomach doesn digest itself

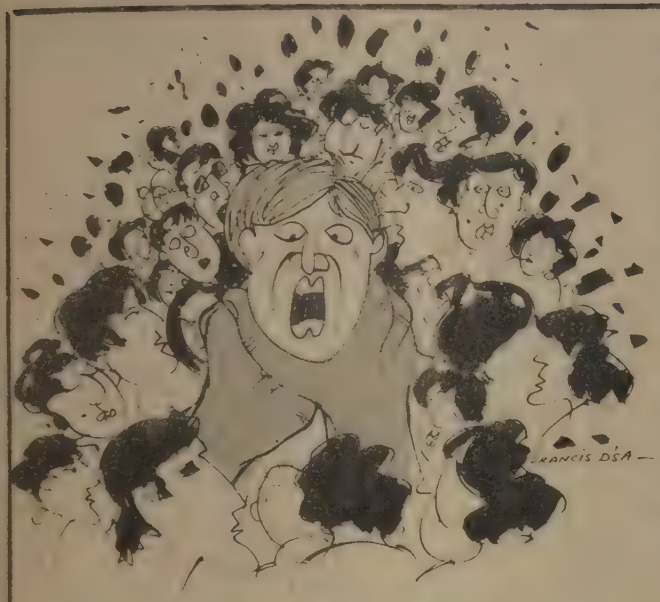
The pepsin in the stomach and the trypsin in the duodenum (" Tell us why . the stomach doesn't digest itself ", September 1977) are secreted in the form of an inactive precursor — pepsinogen an trypsinogen, respectively. The pepsinogen becomes active only on meeting HCl and the trypsinogen on meeting another enzyme, enterokinase. In my opinion, the formation of these proteolytic enzymes in the inactive forms is one of the devices to prevent self-digestion of stomach or the duodenum, in addition to that stated by the author.

SHASHI KANT PANDE
5A/22, Sector-
Bhilai Nagar 490 00

A safer pistol

Considering the point raised by Mr. Bhumesh Mathur that " the magnetic ring may become a common item in the under world " (Letters, August 1977, p. 4), an improvement is possible. The gun should be so designed that the trigger is released only when a magnetic ring of known strength, varying from gun to gun, is used. This could be done by keeping the magnet in the pistol grip under a known tension. Besides, the pistol should also have another magnet concealed in the grip and kept under a known tension, so adjusted that when the specified ring is used it should not yield to attraction, but if a ring with a higher strength is used, it should yield and block the movement of the trigger.

R. S. PRASAD
66, Pallavi, Double Tank Roa
Laxmipuram
Mysore 570 00



CROWDING KILLS...

Crime rates are high in dense urban areas. Crowded public transport frays tempers. That's nothing new. Animal and human studies have suggested links between crowding and sociological problems. Now, for the first time, researchers Garvin McCain, Paul B. Paulus and Verne C. Cox of the University of Texas, Arlington, USA, have been able to establish firm links between crowding and death rates in man. The results of the 26-year study of an unidentified maximum security prison (between 1969-1976) and of a maximum security psychiatric hospital (1953-1969) show that crowding does increase death rates. Human experiments usually lack precision because of the several uncontrollable factors. The Texas psychologists' studies of institutionalised individuals are the closest to laboratory conditions. McCain explains " In a prison, everyone gets the same health care and diet and you know how much time a person spends in his cell, or interacting with others".

The study dealt mostly with the 45 and over 45-year-olds. They found that the death rate doubled in the overcrowding years as compared to the years of less crowdings. They also compared the blood pressure of inmates housed in crowded six- and three-man cells with inmates of two-man cells. In the two-man cell, each man had an average of 29 square feet (2·6 sq m) for himself, compared to the 19 square feet (1·7 sq m) in crowded cells. Often the inmates had to stay indoors, except when they bathed or ate. The temperature in the crowded cells went up to 110°F (43·3°C) at the top of the cell. There was a significant 'high' in the blood pressure in cramped crowded cells. In the psychiatric unit, they found that the death rate ranged from 0·27 per hundred when the population was 369, to 2·8 per 100 when the population was 630. The Texas University survey did not keep tabs on released inmates. Deaths might have occurred soon after release. McCain hesitantly suggests, there might be a similar trend in other institutions too (schools, and places of employment) and also crowded neighbourhoods or entire cities.

Animal studies have shown similar results. Apart from increased blood pressure, overcrowding brings about psychological stress which can affect immunological mechanisms.

DO ANIMAL POPULATIONS REGULATE THEMSELVES?

Until there is a better hypothesis regarding the regulation of animal populations in nature, we will have to make do with V. C. Wynne-Edwards', put forward 20 years ago. What he suggested was that many, and perhaps most, animals, must regulate their populations before the stage of food exhaustion is reached, and that they do this by social competition. He was certainly able to prove his hypothesis with respect to the red grouse (*Lapoqus seoticus*) at Aberdeen (Scotland). Each autumn, young males fight for territory with established males, and the losers are thrown out and die within six months. Thus, population density is regulated.

Other examples of a behavioural mechanism to regulate population were put forward at a symposium on Population Control by Social Behaviour held at the Institute of Biology, London, in September. In woodmice (*Apodemus sylvaticus*), for example, the population remains relatively stable from winter to winter, but the summer population, which is highly variable, is smaller than the winter population. The size of the winter population (food is scarcer in winter) seems to be regulated by a density-dependent process which starts in summer. This process seems to involve aggression towards newcomers and dispersal of young ones.

There is growing evidence that odour may play an important part in population processes in mammals, through its importance in behaviour. Social dominance can be marked by odour in several species like rabbits and marmosets. The rise in dominance is accompanied by increased production of odour. Odour can also be used to deter intruders and serve as a boundary landmark.

BUILDING ROADS WITH SAWDUST

Scientists of the Archangel Lignin Laboratory attached to the USSR Cellulose and Paper Institute were looking for a use for lignin, a proteinaceous waste of the paper industry. They found one: it makes wonderful road surfaces on snow. By warming up the snow surface a bit, they were able to mix the sawdust and compact it to a hard surface. They claim that such roads can last up to a year and can withstand even heavy loads of truck traffic.

MOP NUCLEAR WASTES WITH GLASS

Dr. Theodore A. Litowtz, Pedro Macedo and Joseph Simmons of Catholic University, Washington DC, have developed a new porous glass which is three times as strong as the conventional glass and is, therefore, physically durable. It is also chemically inert. It can be used to soak up radioactive waste containing liquids; the liquid is then driven out and the pores sealed with the nuclear waste residue embedded inside. It can also be used for long-term storage of radioactive wastes.

SUPER POWER CELL

A single cell of this new variety developed by Westinghouse in the US produces 1·1 volts. But a 24-cell battery weighing 1·67 kg has a capacity of 3·5 kWh. Compared to the conventional lead battery, this new silver-iron battery has a capacity five times as great and twice that of a nickel-cadmium battery, according to a report in *Chemical and Engineering News*, **55** (43) 5, 1977.

The new battery, however, is very expensive. Hand-assembled at present, a single 24-cell battery would cost $10,000, a significant part of the cost being the cost of silver which, fortunately, can be recovered.

The cell has a porous iron anode and a silver oxide cathode; the electrolyte is a solution of 30 per cent potassium hydroxide and 1·5 per cent lithium oxide. The anode is covered with a seven-layered polypropylene coat of controlled porosity. This acts as a cell separator. On discharge, the iron gets oxidised to magnetic ferrous oxide and the silver oxide gets converted to pure silver. The battery can be recharged up to 200 times without any loss in efficiency and will be useful in long life and deep discharge applications.

BEATING THE EARTH TO SHAPE

The Earth was beaten to shape by external forces, according to two New York scientists, Carl K. Seyfert and John G. Murtaugh of Buffalo State University (USA). And these external moulding forces, they believe, were huge meteors that made craters measuring at least one kilometre across.

These celestial hammers, they suggest, gave rise to hot spots and mantle plumes

which could have triggered off continental break-ups and brought about changes in the directions of sea-floor spreading.

Do impacts really lead to orogenic (mountain building) activity? Seyfert and Murtaugh explain that impact with large bodies thins the crust and in some cases the mantle material also by cratering. This along with other side effects and isostatic uplift may allow mantle material to well up and form plumes. Where are those gigantic craters? you might ask. The sea-floor spreading and volcanic activity would have obliterated them.

And then there is circumstantial evidence for this preposterous sounding theory: periods of increased impact coincide with periods of high orogenic activity. The geologists state that, of 18 periods of orogenic activity, 12 do correspond to impact epochs.

At present we don't have a satisfactory explanation for the initiation of plate movements. Maybe, the asteroid impacts are the answer.

LIGHT ON MEMORY

Remembering is a complex process (See SCIENCE TODAY, November 1977). Several factors govern the memory processes. Jeremy Cherafas, Sub-department of Animal Behaviour, Cambridge (UK), had conducted a study on newborn chicks which suggest that light is somehow involved in the memory processes. Reporting in *Animal Behaviour*, Cherafas states that several disparate factors influence brain development and perhaps vision and memory sub-units in the brain are linked to a single unit by stimulation with light. However, this is just a speculation.

Cherafas raised two sets of chicks from hatching. Each chick had its own cubicle in the incubator. One set of chicks was given one hour stimulation of dim light 18 hours after hatching. The other group was not exposed to light. The next day he gave both sets a simple visual task. The chicks were let loose in a white arena. On one of the walls was a red mapping pin coated with a distasteful chemical. Little chicks peck at everything in sight while investigating what's good to eat. In the process, each chick pecked at the pin. Once it had learnt of the repulsive chemical, the chick was returned to its compartment.

Several hours later, the test was repeated. This time there were two pins — one red and one blue — on the arena walls. Chicks that had been exposed to light on their first day of life, it was found, remembered the distaste on the red coloured pin head and avoided pecking at it, whereas the control group chicks pecked at everything in sight — even the red pin which was earlier covered with the chemical.

BLOOD IS NOT THICKER

. . . than water — for little children. When faced with a choice of saving either a parent or a friend in a danger situation (and where only one choice is possible) little children tend to choose their friends. Harvey J. Ginsburg, Sandra Hense and Brian Bielefeld of Texas State University (USA) studied children's response to hypothetical danger situations. They selected a group of 70 children between three and 10 years. In the 25 children of the age-group three to six years, 13 children opted to save friends. Only three children out of 45 in the age-group six to 10 opted to save friends. The younger children often explained their reason for the choice as "because my friend is little" which meant older relatives could fend for themselves. Blood gets thicker than water only at the later stage. The Texas scientists attribute this to cultural factors. Loyalty, they claim, is a learned process. This trend becomes noticeable around the age when the child begins schooling and expands his social circle.

This is in contrast with the kin selection theory which says our selfishness is built-in. According to this theory, every person wishes to propagate his genes. Therefore, a person tends to help his relatives over others. The nearer the relationship, the greater the number of common genes and so the greater the (self) interest. Sociologists who support the "selfish" gene theory argue that littleness perceived by the young rescuers is an indication that the small children possess physical features that release caring and aid-giving on an innate basis and that this factor "temporarily overrides kin selection." Another explanation is that the possibility of reproducing one's genes is possible only after pubescence; perhaps the selfishness, too, creeps in then.

A SLIMMING PILL

Most slimming preparations lose their effectivity with time; they stop inhibiting the appetite. Dieting is tedious for many. How can you eat and stay slim? That's possible only if the body does not absorb what you eat. There are surgical procedures — intestinal bypass — where the absorbing surface area of the gut is reduced. But this is done only in extreme cases. Now an Illinois University (USA) scientist, M. Hussain, has developed a compound that coats the intestine's absorbtive surface so that food cannot be absorbed (*Journal of Pharmaceutical Sciences*, **66**, 709, 1977).

The compound, perfluoroocyl bromide, is chemically and biologically inert. It is used at present as a radio-opaque contrast medium. Immiscible in water, it has a low surface tension that helps it to spread evenly over the intestinal absorbtive layer, the mucosa.

In animal studies, the intestine surface remained coated for one and a half hours. Rats given the compound during their feeding period lost weight. The controls given plain water gained weight as expected. The researchers are now designing the drug for man. Will the drug work? We have yet to see. When food passes unabsorbed through the body, the hunger sensation might not be satiated.

DYES CONCENTRATE SOLAR ENERGY

Silicon solar energy converters are efficient only in a particular range. They function best at wavelengths of 7,000 Å. Wavelengths far from this are unusable. Plastics implanted with dyes extend the usable range and also concentrate the light falling on solar cells.

Ahmed Zewail and his colleagues Barry Schwartz and Terry Cole of the California Institute of Technology (USA), have developed a new process of using three dyes: two "donors" and an "acceptor" to boost the efficiency of the silicon cells. The donors absorb the incident light and then transfer it to the acceptor which re-emits it in the usable range.

Sheets of plastic collectors are less expensive than lenses. Because of the difference in the refractive indices of air and plastic, 75 per cent of the light gets trapped in the sheet and is conveyed to the edges where it is re-emitted as a bright glow. Narrow strips of silicon material placed at the edges of the collector will be efficient collectors. This will also make it cheaper. Incident light at any angle is conveyed to the edges and so the concentrator can be used even on cloudy days without the need of costly equipment to track the Sun. Lenses used as concentrators have another disadvantage besides the high cost. They focus all incident wavelengths and the shortwave high-energy light heats up the concentrator and reduces its efficiency. In the plastic sheet-concentrator this is

avoided: the heat is spread over the large area of the sheet.

At present, the sheet collectors have extended the range of usable energy from 7000 Å to 4000 Å. The California scientists hope to extend it to 3500 Å by trying out other dyes and by manipulating the shape of the concentrator. The technique is not yet ready for commercial use, but the prospects are bright.

DOUBLE STAR SYSTEMS MAY HAVE HABITABLE PLANETS

One of the reasons why a star like Alpha Proxima, though a favourite backdrop with science fiction writers, is ruled out by many scientists as an abode of life is that it is a member of a two-star system — one revolving around the other — and hence any attendant planets are likely to have an unstable orbit. That is, they would not remain orbiting around their sun for very long. This view has now been countered by Robert S. Harrington of the US Naval Laboratory, Washington DC in the *Astronomical Journal*. He has investigated a large number of three-body systems where one body is of planetary size and the other two stellar. He has calculated that in such systems a planet can have a stable orbit if the two stars are very close together or very far.

Applying his results to the solar system, he estimated that if the Sun were replaced by two stars of half solar mass each and separated by 39·2 million miles, Mercury would be ejected from the solar system, but the rest of the planets would be unaffected. Similarly, with Jupiter replaced by another Sun, only Mars, the nearest planet, would move into an unstable orbit, and may eventually be ejected.

Estimates of the number of planetary systems or habitable planets should not, therefore, exclude double-star systems ***per se***. Harrington's study adds interest to the recent discovery of three giant planets with masses of 7, 6 and 11 times our own Jupiter in the binary system 61 Cygni by Russian astronomers.

A MOUNTAIN IN A TUNNEL

. . . Usually, it is the other way round. The US Environmental Protection Agency (EPA) wanted to see how mountains affect air flow. The mountain model shown here is being measured prior to tests in the wind tunnel (seen in the background). The air turbulence and air flow characteristics will indicate the pattern of dispersal of air-borne pollutants.

COLD ROOTS ON LIFE

Life is almost synonymous with warmth. Yet scientists are now telling us, seeds of life — prebiotic matter — might have evolved in the below 0°C temperatures of inter-stellar clouds. V. I. Goldanskii of the Institute of Chemical Physics, USSR Academy of Sciences, Moscow explains (in *Nature*, **269**, 543) how this could have happened.

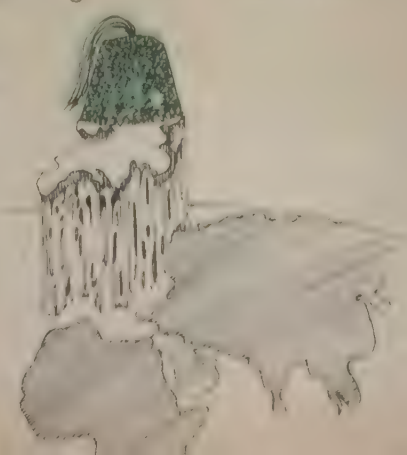
Generally, a minimum temperature is necessary for the synthesis of prebiotic matter and this temperature is much higher than that of the interstellar clouds which is perhaps only a few degrees K. Goldanskii uses quantum mechanics to explain how the basic prerequisite of classical physics and chemistry could have been bypassed. This phenomenon is known as tunnelling. Tunnelling is the ability of a particle to pass through a region of finite extent in which the particle's energy is greater than its total energy.

Thus cosmic rays penetrating dense interstellar clouds would initiate the formation of complex carbon compounds with the carbon, oxygen, nitrogen, sulphur, hydrogen and phosphorus found in the clouds. The compounds could be extremely complex, says Goldanskii; they might even exhibit simple biological functions. Now, as a planetary system formed, the surrounding dust would abound in the prebiotic material. If by chance a planet with a water-rich surface evolved, the cloud dust would bring in streams of complex organic material — the seeds of life.

TURKEY IS RISING

When the Indian subcontinent rammed into Eurasia, Tibet was elevated to its present status as the roof of the world, an average of four kilometres high. Another roof seems to be in the making — eastern Turkey. The present elevation of this region is two kilometres. But the Arabian crustal plate is still pushing and instead of gradual thickening, eastern Turkey is thickening at once and is rising up as a block.

A. M. Celal Sengor, State University of New York, Albany, who has studied the Turkish crust has found that it is deforming internally and appears to be thickening. He has compared the style of volcanicity and volcanic geochemistry deformation and tectonic setting to those of the Tibet plateau; he found they were quite alike. Says Sengor, "It appears that it is beginning to be Tibetanised".



A NEW PLANET?

Astronomers have often suggested there could be one more planet in the solar system. Now they are faced with a new object and can't decide what it is. Charles Kowal, the astronomer who discovered the 13th and 14th satellites of Jupiter has found an object orbiting the Sun between the orbits of Saturn and Uranus. He spotted the object on 18 and 19 October, 1977. Looking back into earlier plates, an Arizona astronomer, Tom Gehrels, spotted it on plates of 11 and 12 October. It was finally photographed on 3 and 4 November.

Could it be an asteroid, or an escaped moon or a comet? Its orbit, which is nearly circular, proves it isn't a comet. Comets have an extremely elliptical orbit which takes them out of the solar system. It is too far from the asteroid belt to be termed an asteroid. It is too small to be called a planet. From its brightness, it appears, the object would have a diameter of about 660 km if its surface is like that of the Moon. If it has a darker surface, it would be much larger; the range of size would be between 220 and 880 km. Its 'year' is estimated to be between 60 and 120 Earth years. Astronomer Kowal likes to call it a "planetoid".

It isn't surprising that the object Kowal has spotted was not seen before; it is too dim for that. Kowal's discovery was a complete surprise even to him. "I would have been less surprised to discover a tenth planet beyond Pluto", he said.

It is quite likely there are other such objects — bits left over from the formation of the solar system.

The untouchable toilet

In India, toilet is a dirty word. It needn't be.

Most people really treat their toilet dirty. No other room in the house gets as little attention. No room needs it more. What we choose not to see doesn't bother us at all. Well here's something that will:

A dirty toilet doesn't just look and smell unpleasant. It is unhealthy, unhygienic, even positively dangerous.

That's the plain truth. Not understated. But not exaggerated either. So perhaps you should ask yourself a question...

Is your toilet as clean as you'd like it to be?

There's only one person who need know the answer. You.

Even if you get the sweeper to clean it every morning, is he doing it as well as he should. Or as quickly as possible?

If you're not happy with your answer, here's something you'll be happy to hear of... Sanifresh.

What is Sanifresh?

Sanifresh is a lavatory cleanser that does a lot of dirty work for you. Flush the toilet first. Then sprinkle Sanifresh generously inside the toilet bowl. Give it 3-4 hours to act. Better still, leave it overnight. Then flush again. If the flush does not work, pour a bucketful of water. And there, all your cleaning problems have gone too!

Sanifresh acts 3 ways:

1. Sanifresh cleans thoroughly.

It contains a highly active cleansing agent that removes the most stubborn stains. Sanifresh cleans where a brush can't even reach.

2. Sanifresh gets rid of dangerous germs.

A toilet can be a breeding ground for germs, a likely source of disease. Sanifresh gives you the kind of protection ordinary 'phenyles' cannot. So you can be absolutely sure your toilet is absolutely safe.

3. Sanifresh banishes unpleasant odours.

A toilet can smell awful. Bad ventilation traps odours and makes the problem worse. Sanifresh contains a deodorant that freshens the air and dispels odours.

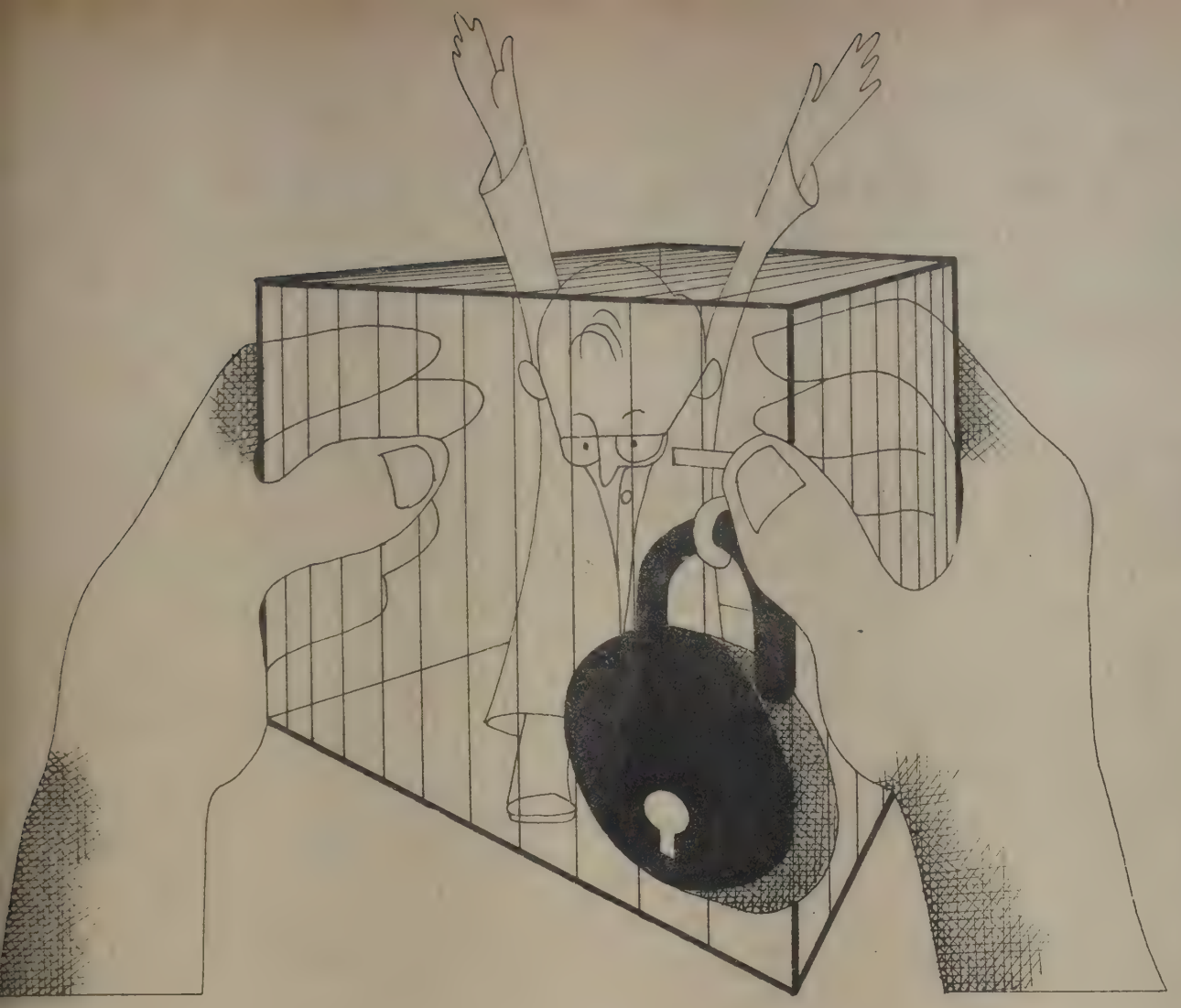
How often should you use Sanifresh? Considering how important toilet cleanliness is, there's just one answer. Every single day.

It does all your dirty work to keep your toilet clean.

BALSARA
—FOR MODERN AIDS TO BETTER LIVING

BALSARA & COMPANY (PRIVATE) LIMITED
43, Nagindas Master Road, Bombay 400 023

CHAITRA-BLS-82



Padekar

ON NURTURING SCIENTIFIC EXCELLENCE

RAJA RAMANNA

It must be difficult to be a scientist in a country where the milieu is still one of non-science: thus commented a distinguished scientist from abroad to the author. How difficult is it really? In his anniversary address to the Indian National Science Academy early this month, which is reproduced below, the author does some plain speaking. . .

NEARLY all my distinguished predecessors have used the occasion of the Anniversary General Meeting to express their views on the functions and organisation of science in India. I feel that this year, in particular, there is a special need for a close examination of these issues; for, while Indian science is on the threshold of great achievements, its organisation, as things stand today, may prove to be a source of hindrance to its early and effective application to the solution of national problems. A delay in its application may lead to wrong conclusions as to the value of science to society itself and detract from the use of the methods of science to future developments, be it in the sphere of increasing the country's industrial potential or building a national personality by a reorientation of our philosophy to suit the 21st century.

It will be recalled that in August 1977, the Council of INSA had issued a press release expressing concern over the inadequate realisation of the value of scientific methods, the limitations of such an approach and why the reorganisation of existing structures based on consultation was required in order to make it a more efficient tool for national development. In the beginning, only some abstracted versions of the release appeared in a small number of dailies. However, its impact became more perceptible later.

I am glad to note that our two sister Academies, the Indian Academy of Sciences and the National Academy of Sciences, whose Presidents are both Fellows of this Academy, have also expressed views similar to ours, but perhaps in a more pointed manner as they were issued much later than the Press Release of the INSA Council and also after the decision of the Government to make major changes in the existing framework of scientific organisations. It is gratifying to note that a constructive view of these changes has emerged, taking into account the importance of inter-disciplinary research activities. It is a happy augury that the various Academies have independently come to almost identical conclusions. As these conclusions taken in totality reflect the views of a large body of the science community, I take it to mean that science Academies have an important role of an advisory nature to play in the formulation of science policy.

Consultative processes are essential in a country like ours which has a large and diverse science structure and where the implementation of science policy is beset with enormous difficulties. It is only a truly scientific society which can effectively examine the vast potential of present-day science and suggest methods by which it can be kept in the forefront of development and not allowed to take on an imitative role, incapable of providing the required level of confidence needed to achieve national self-reliance. In a democracy, no set of scientists, however carefully they may be chosen, can replace the collective wisdom of a body like INSA, which has indeed been recognised by the Government, as early as in 1945, as the premier society representing all branches of science. I would, therefore, like to make a plea for the effective utilisation of the potential of the Academy for the benefit of the country much in the same way the USSR Academy of Sciences, the National Academy of Sciences, USA, and the Royal Society of UK are given pride of place in their respective countries.

It is to be noted that the USSR Academy of Sciences even implements policy. We, as a body of scientists, should not appear to be bargaining for leverage. On the contrary, we are here only to give our considered advice. If confidence is reposed in us, we will naturally rise to the occasion in a manner that would enhance the prestige of Indian science.

The reorganised National Committee on Science and Technology has, as one of its members, the President of INSA, and I believe that the views of the Council of INSA will be given due weight at the deliberations of the NCST. We take pride in the fact that the new Chairman of NCST is a distinguished past President of INSA and he has already assured me that our views will be given special consideration.

Among those countries of the world which have a scientific base of some consequence, we are the one that spends the least on science. In spite of this and in spite of the fact that our per capita GNP is amongst the lowest in the world, the quality of Indian science is greatly respected abroad and scientists and students from other countries come to us in fairly large numbers to share the knowledge developed in our laboratories. At various symposia organised by learned bodies, I am amazed to see the excellent quality of work in various disciplines contributed by research workers who are working under the most difficult conditions of financial, administrative and other forms of logistic support. By any norm of national planning, the allocations for science and technology should be increased if we are to survive as a modern nation and not become merely a geographical entity. The usual reason given against any increase of financial support is that we are a very poor country and that we cannot afford more. Some even say that we must cut on science to help one more villager to survive. If we have to make such cuts on science, it is not that one more villager will survive, but it is like cutting the very arm of the nation that can help uplift the villager. In our history, whenever we have allowed ourselves to neglect science, we reached the lowest levels of degradation, especially during the 18th and 19th centuries, a stage from which we have not yet truly come out. We must never let this happen again. We must continue to support science as has been the policy since Independence. This support should be enhanced, and widened in scope, to cover the many developments that are taking place in the world.

Our country is a very large one and it should have every aspect of science operating at all levels, be it basic science (sometimes called ivory tower science) or the kind of " barefoot " technology intended to help in our rural programmes. There must be a continuous flow of knowledge from the high " ivory tower " to the down-to-earth level pervading through the entire scientific community. No branch of knowledge is unnecessary to a nation on the move. As an example of a discipline which does not give the impression of having any immediate value to the community, I may refer to abstract mathematics. This type of mathematics does not even have the possibility of being a source of entertainment like music or painting. It is there for its own sake,

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but is there anybody who would suggest that we should stop support to mathematics in this country? It is not that mathematics should be supported because it does not involve much financial investment (an incorrect statement in itself). It should be supported purely because such support would be in the spirit of involving ourselves in the very foundations of thought and structure of modern science. It is this very spirit that has allowed us to survive in the past as a nation with a remarkable continuity of culture. However, such an attitude requires our accepting the established laws of science as supreme. A very distinguished scientist abroad once said to me that it must be frightfully difficult to undertake scientific research in India because of the widespread atmosphere of non-science. There is no doubt that social conditions affect not only the growth of science, but even the use of scientific methods and, ultimately, the absorbtion of science in the processes of change and development.

Over the centuries, the need rule by law as a sign of civilised e ence has come to be generally cepted. Our lawyers clamour for and swear by Manu, Mitakshara Macaulay as though their pronou ments were the laws of God H self. But few have tried to critic examine their relevance to moc life. If you ask me why there is n for a largescale use of third de methods in our police investigati I would say that it is an outcome of existing criminal procedure code it There have been great advance the forensic sciences, but how m of this has any value in our count The greater use of science in detec of crime can result in lesser use third degree methods and co quently lead to a lesser misuse authority. But this change require acceptance of the laws of scie which have a better claim to bein creation of God. In all material m ters, the laws of science are supre and such is the humility of science t when a more correct law is discover the older one is discarded if there sufficient evidence to do so by feedback process that is natural to However, such ready acceptance newer concepts requires our impl faith in mathematics, statistics, laws of the exact science and th projection into biology.

Sometimes people make a differen between scientific research and ind trial research. This is actually a ve colonial view of industrial develo ment. If the country really has to industrialised in the fullest sense of t word, both must exist simultaneous We can compare science and techn logy to a human body where the le and hands represent industry, but t brain represents scientific researc If we do not have scientific resear helping and controlling industry as well-assimilated part for our develo ment, we will be merely importing n only equipment from outside, but ev ideas. This will completely place in the hands of those who contr industry elsewhere.

By its very natur science requires nurturing of exce lence which is wrongly labelled " elitism ". Good science can com only from those specially fostered in special environment. While we ca have mediocre music for use in resta rants and similar quality work painters to be hung up on the wal of hotels, we cannot afford to hav such a thing as a mediocre scientis To keep a scientist working at h most effective and creative level, h has to be treated as something out o the ordinary. His morale has to b kept at the highest level, otherwis

ne investment made on him will all o waste. It is for this reason dvanced countries give a very special osition to scientists and more so if heir merit is indisputable. It is in the itness of things that a scientist must e treated with solicitude which hould be made a part of national oncern rather than controversy. This cceptance of the scientist's position, owever, requires a proper method of ssessing him.

Research workers can be classified nto three different groups: one just bout to start his work, one at the eak of his activity, and one who helps progress and promotion of science by his overall maturity and experience. In the first category, the identification should normally be available through university gradings. Unfortunately, in India, this method of assessment is not satisfactory due to the large number of graduates being turned out in our universities. In such an overcrowded situation, the identification of a single person who shows great promise becomes very difficult. Consequently, the training of a highly gifted person requires very special attention. It is for this reason that a secondary selection process from among those coming out of universities and their subsequent training are required for the proper development of a research worker in his earlier stages. At middle levels, when the research worker is at his peak of activity, the problem of identification is different as it requires great vision to recognise the merit of a man contributing at the frontiers of science. The identification of good people at this level by means of newspaper advertisements is a futile exercise. For one thing, a scientist in this group usually does not like to migrate from the place he is already in. He is suspicious of new environment and new colleagues. It requires tremendous persuasion to get a good scientist to work in another laboratory on a different set of problems which require his expertise. It is, therefore, hardly likely that he will respond to an advertisement.

It is also difficult to believe that a UPSC type of interview is any better, specially when it takes the shape of a judicial operation. Unless the people who have to work with the scientist concerned are also emotionally involved in the selection process, a satisfactory identification will not result. The so-called objective method of selecting scientists by outside committees may satisfy norms, but fail to identify the best men. The problem is made worse when confidential reports are written on the candidate with a view to avoid any comments concerning his inadequacy with respect to the solutions of particular types of problems. Whereas the objective identification of deficiencies is meant to help in locating a scientist in the environment most appropriate to his strength and weaknesses, it is often used in current selection processes as adverse remarks, thus invalidating the use intended for such reports. Taking everything into account, a certain degree of rational bias in favour of excellence is an essential part of choosing the right man for scientific research. Unfortunately, it is true that there is a tendency to lay too much stress on the dangers of nepotism through relationship, caste, locality and other unpleasant factors. While nobody can deny their existence, it is, I believe, a passing phase. Its incidence can be minimised by an appropriate choice of selection committees and by proper tradition and leadership. In any case, there is always an element of risk involved in any attempt to recognise good people.

Many of the difficulties one faces in selection operations are more due to shortage of posts and to the fact that

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salaries and posts are associated with one another. I have found from personal experience that if there is a delinking of salaries with designation, a younger man can take up more responsibilities because of inherent ability and not necessarily come in the way of the older scientist who may deserve a higher salary due to the passage of time. In the choice of scientists at the very highest levels, other constraints of a non-scientific nature will naturally play a part and it is here that the Academies and learned bodies can play an important role in the assessment procedure.

There has been considerable debate as to who is the user of any technical development that has come out of a laboratory. I am afraid, it is certainly not the Ministry concerned. To me the Ministry is a body which is meant to help the scientist to get on expeditiously with his work, to give all assistance to him in solving administrative problems and to act as a protective agency in legal and other matters that may arise in the coordination between a research laboratory and an industrial user. At least this is how, I recall, Dr. Homi Bhabha defined the role of administration in scientific research. Unless administration has clearly understood its assistance role, there will be much cause for misgivings. Due to historical reasons, many Government laboratories are classified as subordinate offices and are treated as such. This classification has come from British times and has remained unchanged if not in form, certainly in spirit. The

Ministry officials are only too conscious of the fact that all the statutory powers are with them and some of them even insist that they have the last word on the subject, purely for purposes of continuing the status quo. It is possible that the Director of a laboratory can work smoothly with the Ministry, but keeping good relations becomes a major aspect of his activity involving severe compromise on several issues. Usually, the differences are not important when the concerned laboratory is involved only in routine operations. If, however, the Director wishes to make changes and do something out of the ordinary, which is the essence of scientific research and requires a constant process of delegation of powers, it is remarkable how departmental opposition comes into play, a fact noted by Lord Rutherford himself. As I see it, by its very definition, a Ministry's approach is to routinise matters as much as possible and thus, if it is in direct control of a laboratory, only routine work will emerge. On the contrary, all scientific work is based on continuous innovation, be it in scientific administration or in scientific research.

It also does not follow that the user of any results of a laboratory is necessarily the industry concerned. The main concern of the industry is to make profits and its approach to research is that it should lead to increased efficiency leading to increased production rates; but when new processes or new items of development which may have an overall national economic value are involved, the industry in general rarely shows much interest. It is for this reason the autonomy of a laboratory has to be carefully preserved. It is not for me to describe what autonomy immediately implies, and how it can be

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maintained, but I think the Academy should give serious thought to this and prepare a paper taking all aspects of the problem into account and make it available for public discussion.

I would now like to deal with an approach that has been considered as a solution to some of these problems and has been implemented as such. This is the process by which scientists are given secretarial powers. To me this seems to be an admission of defeat; for, it means that it is not possible to delegate powers to scientists to get on with their work and that unless a good scientist is sucked up into a secretarial structure, which is inevitable, he will not be able to survive or protect the interests of science. I do feel that there must be a way out of this, whereby scientists holding high posts can be given appropriate powers, which would be commensurate with their stature and their level of functional responsibility. In some cases, where a scientist is of a high calibre, it may be necessary to him with powers and a status that be even more than that of a Secret The aim of the whole exercise sh be to decentralise effectively decis making powers in order to promote as rapidly as possible progress of science and technol

I have brough your attention some of the difficu concerning organisational matter a laboratory. But the purpose Presidential Address is not to me categorise all these problems. T are being brought to your atten more by way of examples so tha unified approach can be attemp and well before the end of the cent we can say that India has a mat system for the organisation of scie

If, in this context, INSA has play an important role in the pro tion of science, it has itself to unde many changes. It has a legacy constraints by way of very inflexi statutory regulations copied f foreign institutions from the Independence era. Since no chan to the statutes are possible withou three-fourth majority, it really me that no change is possible at all. Fr previous experience, it seems that of a total of 387 Fellows, only ab half of them take interest in the wo ing of the Academy. To improve pa cipation, the Council has encourag the functioning of Regional Chapt and I am glad to report that there continuous inflow of reports of activ from them, particularly those fr Bombay, Calcutta, Hyderabad a Madras. I would urge that if a changes are to be made to the A demy Statutes, the desire should co from the Fellows from the vari regions. Any fundamental changes important issues should be initia only with the full support of Regio Chapters. There is also the questi of how much the Academy shou recognise the excellent work bei done in the country by engineers a medical men from the point of view representation within the Academ

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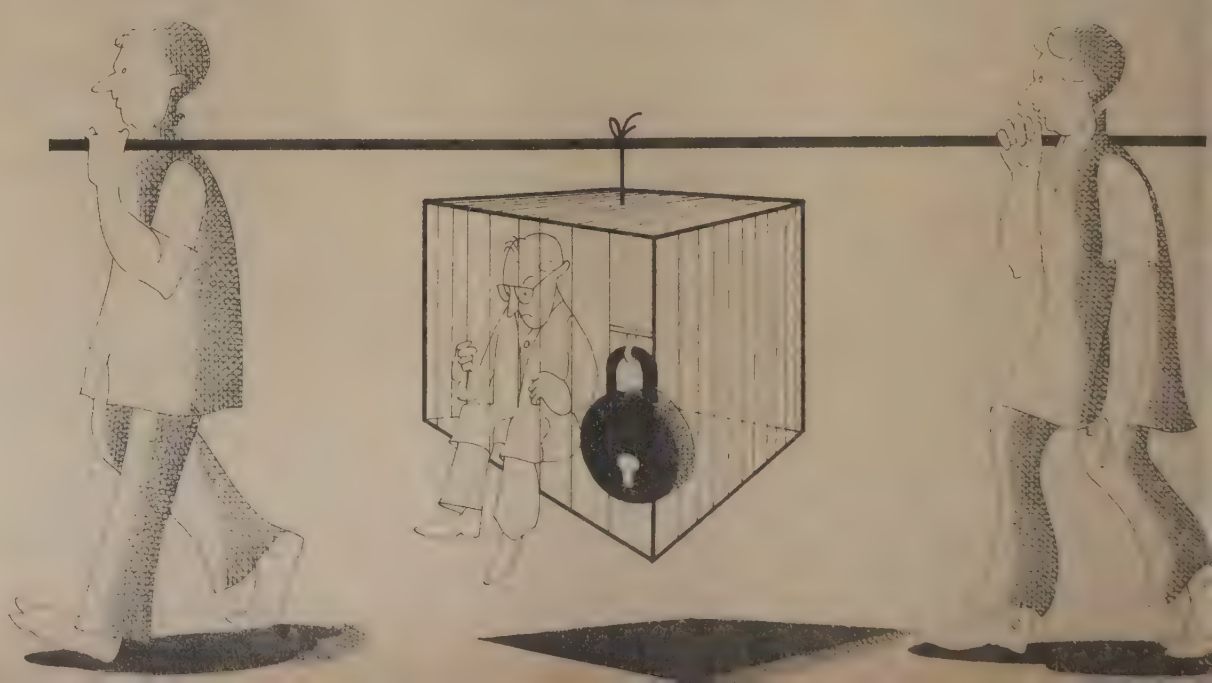
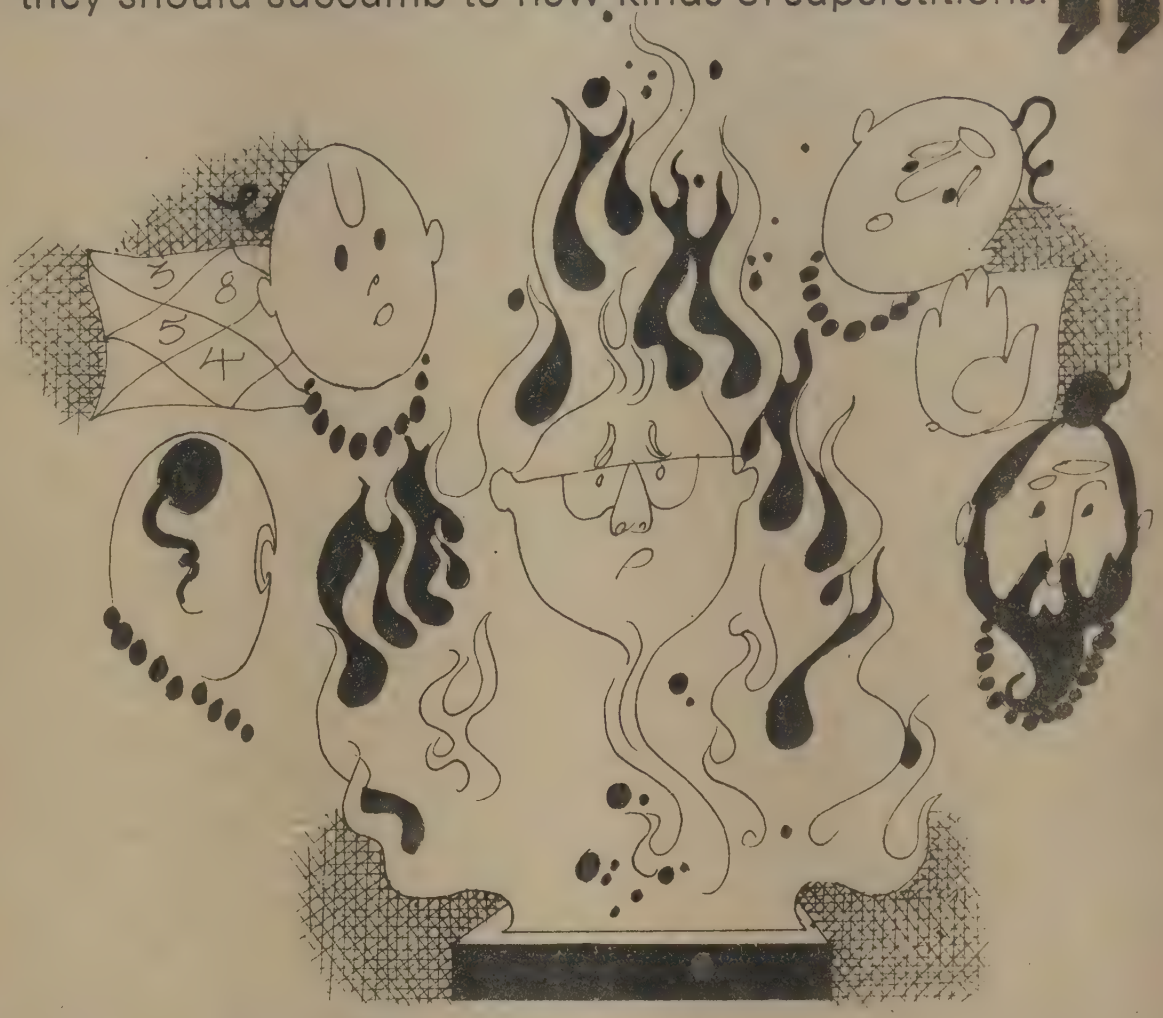


n order to get a proper assessment of he situation in these fields, I have uggested to the Council that other earned bodies should have an affiliaion status to the Academy in some orm, so that there is a continuing xchange of views on the problems f medical and engineering sciences nd other fields of knowledge and etween the learned bodies and the Academy. Close collaboration with State Academies would help in the ollection of information concerning egional and rural problems.

The Academy is here to help all he sciences in India and is committed o taking only a positive and helpful ttitude. Sometimes it is forced into ather unpleasant situations because mong the body of scientists, a code f conduct and ethics has not yet come nto organised existence. We still ave the old complaints of papers eing published in a hurry with nverified results, insufficient credit eing given to junior workers, plagiaism in some form or other and, above ll, difference of opinion between cientists arising from sources of a on-scientific nature or personal preudices. These, I presume, are essenially problems of a transitional ature which necessarily arise during he process of achieving maturity and growth. I would not give too much mportance to these unless one can how that they are indeed causing definite damage to the image of Indian science. At the same time, it should not be the intention of the Academy to shy away from problems and claim a state of *sanyasa*. It should be amidst all scientific controversies bringing forth effective solutions without ever losing its commitment to basic principles.

INSA is essentially a scientific body and will recognise no other solutions on scientific matters except those under the principles defined by science. There is much controversy in the country about imponderables, such as the powers of miracle-men and the effectiveness of various indigenous cures and medicines. I know from my own experience that every other village in the South has its own methods of medication and that a large number of Indian scientists retain their faith in miracle cures. While I doubt the principles on which these cures and medicines are based, I must concede that several of them may indeed provide remedies, psychosomatic or otherwise. But, as far as we are concerned, we can recognise only one science and that is medical science. Unless the claimed cures are understood with respect to biological processes based on the principles of the basic sciences, they can continue only as unverified cures and that, too, only as long as they are not dangerous and do not lead to toxic side-effects. But they cannot be said to be part of medical science. Objective statistical verification of all successes is an essential part of science.

> "... it is surprising that a large part of the world should stress on only the evil aspects of peaceful nuclear explosions. While the social obligations of a scientist, on both the national and international planes, cannot be lost sight of, it does not mean that they should succumb to new kinds of superstitions."



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Another variation of the above syndrome which is very much in evidence in the international scene is the confusion stemming from non-scientific approach to current-day problems. The International Atomic Energy Agency has, in recent reports, analysed the various application areas where peaceful uses of atomic energy are bound to play an important and beneficial role in the future. No less an authority than Academician Kapitza has recently expressed the view that for the effective exploitation of geothermal resources, peaceful nuclear explosions are necessary. In spite of all this, it is surprising that a large part of the world should stress on only the evil aspects of atomic energy. While the social obligations of a scientist, on both the national and international planes, cannot be lost sight of, it does not mean that they should succumb to new kinds of superstitions.

In conclusion, I would like to say that, in the interest of science in India, scientific bodies like INSA must strongly express their views in the formulation of science policy, and the organisation and administration of science; otherwise the very need for their existence will only be a very minor one.

Dr. Raja Ramanna (52) took his PhD from London University and joined the Tata Institute of Fundamental Research, Bombay, in 1949, where he continues to hold the post of Senior Professor. Transferred to the Bhabha Atomic Research Centre (then known as Atomic Energy Establishment), Trombay, in 1953, he became the BARC's Director, and member for Research and Development, Atomic Energy Commission, in June 1972. Dr. Ramanna's scientific work has been on neutron thermalisation including pulsed neutron experiments, design of reactors and other neutron multiplying systems and experimental and theoretical studies on low energy nuclear reactions with special reference to nuclear fission. He had collaborated in the design, installation and commissioning of the research reactors Apsara, Cirus and Purnima at Trombay and the Cyclotron at Calcutta. He is now Chairman of the Planning and Coordination Committee of the Reactor Research Centre at Kalpakkam, for planning and implementing a fast reactor programme in India.

Now President of the Indian National Science Academy, and a member of the National Committee on Science and Technology, Dr. Ramanna is also Vice-President of the Indian Academy of Sciences and a fellow of the National Academy of Sciences and the India Society of Engineers. He was awarded the S. S. Bhatnagar Award for physical sciences in 1963 and the National Design Award of the Institution of Engineers (India) in 1974.

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comets and the origin of life

Did life begin on Earth as conventionally believed? Or, could it be that the building blocks — the organic molecules — came from the nuclei of comets? After all, superstitious beliefs do link comets with afflictions on the Earth. . .

JAYANT V. NARLIKAR

SUPERSTITIOUS beliefs in many cultures, ancient and modern, associate comets with evils in the form of pestilence and death. A scientific theory linking terrestrial epidemics to comets was recently put forward by two internationally known astrophysicists Sir Fred Hoyle and Professor Nalin Chandra Wickramasinghe in a couple of special preprints from University College, Cardiff, UK, and through an article in the *New Scientist* (17 November 1977, p. 402).

The theory of Hoyle and Wickramasinghe (H & W) in fact goes further than that. It challenges the long-held concept that life on Earth originated on the Earth. According to Hoyle and Wickramasinghe, this was not the case; life started here because its basic building blocks were deposited on the Earth through cometary debris.

The conventional theory of origin of life due to A.I. Oparin and J. B. S. Haldane is based on the idea that the simple inorganic molecules of water, ammonia, methane, etc were converted into prebiotic molecules (that is, molecules forming the basic building blocks of life) in a 'primeval soup'. This process requires energising events like thunderstorms to occur frequently on the primitive Earth. Also, it is assumed that the prebiotic molecules are stable, which requires the primitive atmosphere to be of reducing rather than oxidising type, with a predominance of molecular hydrogen.

Hoyle and Wickramasinghe challenge this concept. Hoyle has argued that the original atmosphere is more likely to be oxidising rather than reducing and this inhibits the development of the primeval soup. There seems to be no astronomical or geological basis for early excess hydrogen. Hoyle and Wickramasinghe also question the validity of interpreting the results of the various laboratory experiments in prebiotic chemistry in support of the Oparin-Haldane idea since the conditions of the primitive Earth may have been different from the controlled conditions of these experiments. What then is the alternative?

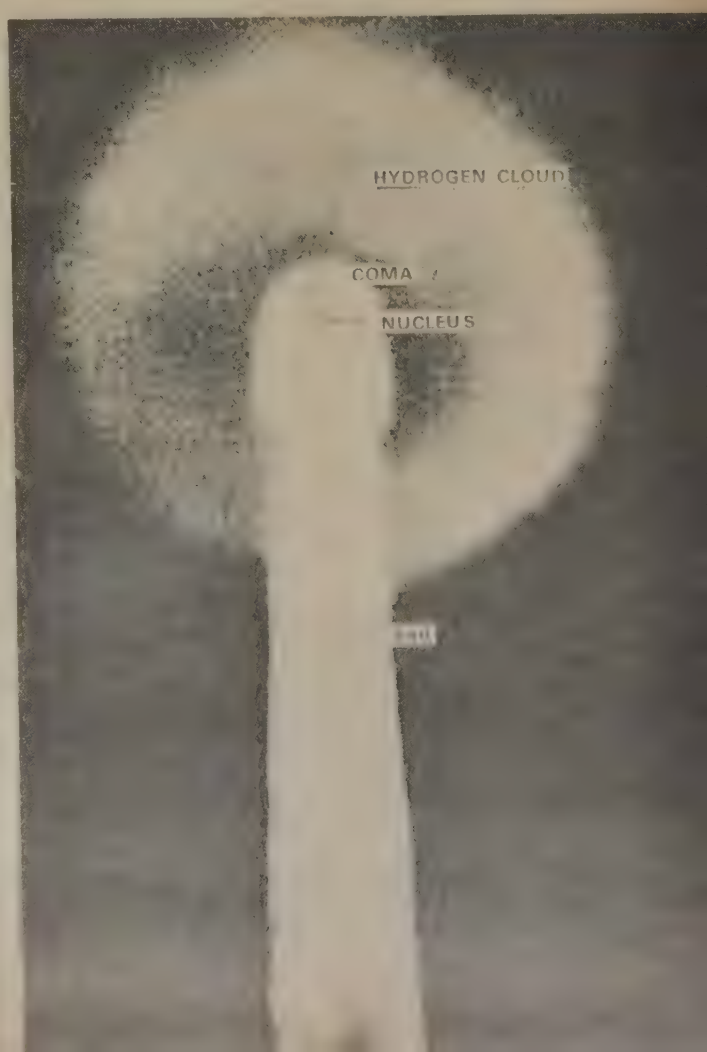
According to these authors the alternative lies in the cometary nuclei. Cometary nuclei are a few kilometres in radius and are known to contain organic molecules as complex as CH_3CN (methyl cyanide) and HCN (hydrogen cyanide). Smaller molecules and radicals like CO^+, CO^+_2, N^+_2,C_2, C_3,OH, CH, CH_2, NH, NH_2, CN and H_2O^+ are present in cometary comas and tails. These could be degradation products of complex bipolymers and of H_2O. There are indirect indications of the presence of polyformaldehyde or polysaccharides in dust tails of comets

How do comets happen to have such complex prebiotic molecules? It has been known for some years now that the interstellar medium contains many complex organic molecules and radicals. H & W suggest that during the process of formation of the Solar System from an interstellar molecular cloud, such material may have been picked up by cometary nuclei. Since comets make periodic trips to the vicinity of the Sun (their orbits are highly eccentric, unlike those of planets), during each such visit the volatile material in the nucleus tends to boil off. The temperature falls of and the material freezes as the comet moves away from the Sun. The cycle of 'hot and cold' phases preserves only those structures which can best withstand such extreme conditions (300°K to 100°K).

The prebiotic material is processed by sunlight during the passage of the comet near the Sun. The processed material is then frozen as the comet goes away from the Sun, to be reprocessed further during the next approach to the Sun. In this cyclic process — lasting for millions of years — may have evolved the photosynthetic bacteria and the thermophyllic bacteria, for example. The type of living organisms generated in a comet would have to be determined by the type of responses needed for survival in the changing conditions.

Finally, life could have been transplanted to the Earth by a soft landing

(Top, left) Comet Kohoutek photographed by Charles Kowal at Palomar Observatory, USA. The tail, blown by solar wind, was about 21 million kilometres long. (Below) The various parts of a comet. The "tail" is made up of large amount of dust. The "nucleus" within the head region, the "coma", is believed to be a dirty ice ball consisting of frozen gases and dust particles

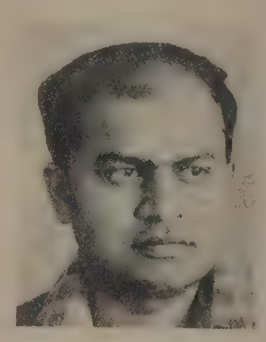


of an icy comet carrying primitive organisms about four billion (4×10^9) years ago. And there is no reason to expect that this process is not occurring now! While the resistance of native life to new type of life forms must eventually destroy these invaders, Hoyle and Wickramasinghe suggest that this process may sometime result in the appearance of new epidemics of a global nature like the influenza of 1918-1919 or the plague of Athens in 429 BC. They suggest a microbiological vigil of the stratosphere to ward off such future invasions.

This idea is controversial and will no doubt evoke criticism from microbiologists, epidemiologists as well as from astrophysicists. Just as comet Kohoutek, though a visual flop, was nevertheless rich in scientific data including the existence of complex molecules, future comets will be studied more closely with a view to testing this hypothesis. It is also necessary to check whether some of the epidemics of untraced terrestrial origin can be linked to the passage of a particular comet in the past.

In response to my enquiries at the Virus Research Institute, Pune, its Deputy Director, Dr. Kalyan Banerjee informed me that the concept of celestial origin of life had been suggested earlier by Richter in 1865 and later propounded by Helmholtz in 1884 and by Arrhenius in 1903 and 1908. Arrhenius even suggested that bacterial spores could travel through the interstellar space under propulsion by pressure of light and attracted by gravitation. This might be possible for viruses like influenza also, although they may not be able to withstand as trying conditions as the spores can. Dr. Banerjee also pointed out that there have been epidemics whose origins are difficult to trace, for example, the Kyasanur Forest Disease (KFD) in 1957 in Karnataka. A similar virus (Langat virus) is found in Malaysia although it does not seem to be epidemiologically linked with the KFD virus.

Many medical experts will be reluctant to accept the extraterrestrial origin of diseases on the present evidence. The proponents of the theory will have to collect statistical evidence in support of any correlation between comets and epidemics. Simultaneously, attempts should be made to look for quantitative as well as qualitative data on the presence of complex organic molecules in passing comets. A theory of formation of complex organic m cules in the interstellar space is to come, and the authors' qualita considerations of how such molec get into comets and evolve fur need to be backed by quantita estimates to convince the many s tics. All the same, their idea lin comets to the origin of life and epidemics is probably the first scie fic attempt of its kind and dese careful consideration.



Professor Jayant Vis Narlikar (39) has h distinguished acad and research ca much of it at C bridge University, where he was awa both his PhD and He was a staff mem of the Institute Theoretical Astron at Cambridge University till 1972 b joining the Tata Institute of Fundame Research at Bombay where he is Professor of Astrophysics. Fellow of the R Astronomical Society and the Cambr Philosophical Society since 1963, he elected Fellow of the Indian Academy Sciences in 1974 and of the Indian Nati Science Academy in 1976. He was Jawaharlal Nehru Fellow from 1973 to 1 His publications include both research pa and popular articles on topics in theoret physics, gravitation, cosmology, astrophy etc.

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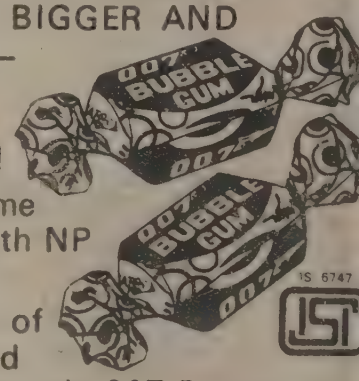

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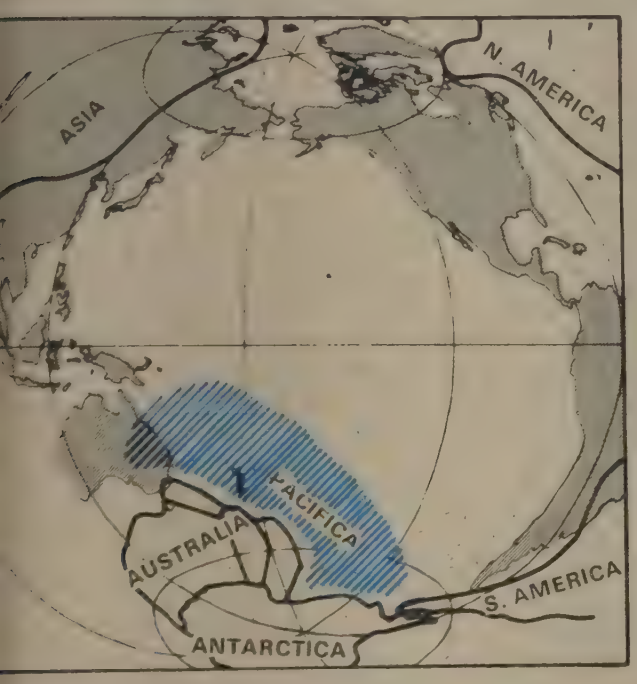
EOPHYSICS

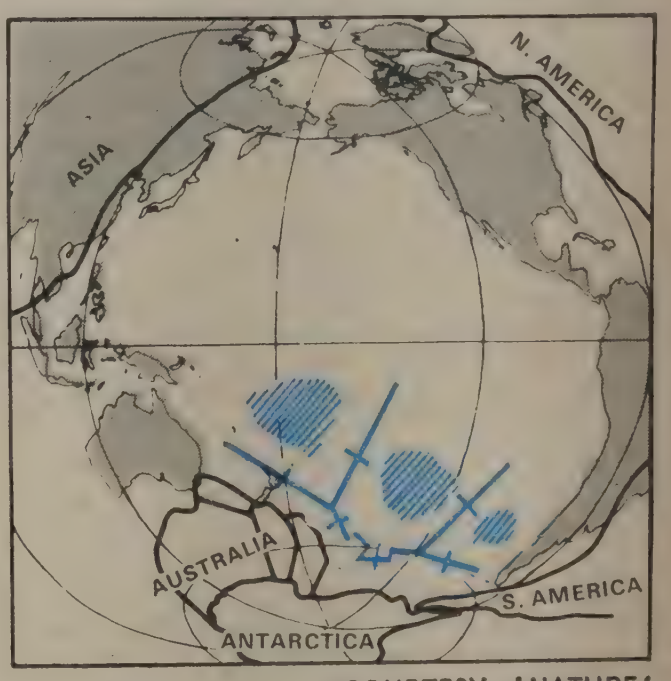
ost Pacifica Continent

TOWARDS the beginning of this century, the famous geologist, Alfred L. Wegener, proposed is celebrated hypothesis that South merica, Africa, India, Australia and ntarctica were once part of a super-ontinent (Gondwanaland) which roke up about 200 million years ago ıd the pieces have since drifted apart.



25 million years ago

180 million years ago



65 million years ago

COURTESY : 'NATURE'

chematic model for the break-up of Pacifica. esent-day continents are marked in colour. ark outlines denote the positions of the ntinents then. Dark lines in colour denote e centres of spreading

arly evidence in favour of this hypo-nesis came mainly from the similarity f flora and fauna of these continents nd from the remarkable fit of the ast coast of South America with the est coast of Africa. Radioactive ating of coastal rocks and palaeo-agnetic investigations provided rther support for the drift theory. ut the real clincher came recently om seismological, gravitational and agnetic observations of the ocean oor. These observations have led to ne theory of ocean floor spreading nd plate tectonics (see SCIENCE ODAY, January 1971).

According to this theory, the ismologically active belts are the gions where important crustal action kes place. For example, mid-oceanic egions where shallow-focus earth-uakes are observed are the linear egions where new crust is forming, nd pushing the existing crust on ither side towards the deep-focus rench system where the oceanic rustal material sinks deep into the antle under the continents. The ceanic crust is believed to move as a igid plate from the mid-oceanic ridge wards the continental margin. It is further surmised that if, due to any reason, an upwelling process in the mantle starts at a point beneath a continent, the continent will split and the fragments will drift apart. (Lateral spreading from the point of rift will create a new ocean basin.) There is a possibility that a drifting continental block may collide with another continent. The resulting compression may thicken the crust in the region of impact. The Himalayas and the Alps are believed to have been formed this way, by the Indian and African blocks having collided with Eurasia.

Besides the Himalayas and the Alps, there exist circum-Pacific mountain belts — in the western South and North Americas, and east Siberia, whose morphology, seismicity and crustal thickening appear to be similar to that of the Alpine and Himalayan chains. Did each of these mountain belts also arise as a result of collision between two continental blocks?

Various workers have suspected that this might have indeed happened. The suspicions are due to some anomalies observed in the geological, palaeomagnetic, flora and fauna records of the circum-Pacific crust. The anomalous rock types are believed to be the survivors of the colliding crustal blocks. These conjectures have been further integrated (by A. Nur of Stanford University, USA, and Z. Ben-Avraham of the Weizmann Institute, Israel; *Nature*, **270**, 1977, p. 41) to support a speculation, originally advanced by geographers to explain the similarity of the flora and fauna of circum-Pacific regions. The geographers speculated that the chunks which collided with circum-Pacific continents and gave rise to the circum-Pacific mountain belts were probably parts of a big continent, Pacifica, which existed near the south Pacific about 200 million years ago. Around 180 million years ago, this continent split into four blocks which, riding the Pacific plates, drifted towards the west coast of North and South America and the east coast of Asia. They collided with the respective continents about 65 million years ago, and caused the crustal thickening (mountain chains). The tell-tale fragments are now embedded in these mountain belts. This, according to the authors, is the story of lost Pacifica.

RAMA

[Prof. Rama is with the Hydrology Department at the Tata Institute of Fundamental Research, Bombay.]

PSYCHOLOGY

Imitation of Gestures by Babies

Current views on infant development hold that a human baby can imitate facial gestures only after 8 to 12 months of age and that this time is spent in development of such skills. Recent studies by two University of Washington, Seattle (USA), psychologists show that imitation may not be a slowly acquired process after all. In a series of experiments with infants between the ages 12 and 21 days, the psychologists, A. N. Meltzoff and M. K. Moore, have found that babies are capable of imitation of facial gestures — even a 60-minute-old baby was able to imitate gestures.

Earlier, in 1973, O. Marates of the University of Geneva (Switzerland) had suggested (in her thesis) that one to 2½-month-old babies could imitate

two facial gestures, but the interpretation of her work was limited since some of the factors in her experiments were not controlled.

Meltzoff and Moore (*Science*, **198,** 1977, p. 75) carried out two sets of experiments with full term, normal weight, normally delivered babies. In the first, a group of six babies aged 12 to 16 days, were shown three facial gestures: (1) tongue protrusion, (2) mouth opening and (3) lip protrusion and a manual gesture like opening or closing of the hand and sequential movement of the fingers. Volunteers who did not know which stimulating gesture was presented to the babies had to evaluate video-taped responses of the infants. Another group scored for manual response; they were told that the baby was shown one of the following gestures: sequential finger movement, finger protrusion, hand opening or passive hand. In all the experiments, the baby was first presented with a passive face, then a brief period of stimulation which was followed by a neutral period to see if the baby responded.

The first experiment began with a 90-second period during which the examiner made no gesture, that is, he maintained a passive expression. A 15-second stimulation gap followed, during which the experimenter presented one of the gestures four times. A 20-second period was allowed for response during which the experimenter maintained a passive face again. The stimulus was repeated a maximum of three times in case the baby had not watched it. Between any two types of gestures, a 70-second passive face gap was introduced. In all the four gestures, the volunteers' scoring of the behaviour varied as a function of the gesture they were shown.

In the second set of experiments, the babies — 16–21 days old — were presented with mouth opening and tongue protrusion gestures. For 30 seconds before each test, the baby sucked a pacifier. A 150-second baseline period followed during which the pacifier was removed and the experimenter presented a passive face. Reintroducing the pacifier the experimenter presented the first gesture till he judged the baby had seen it for at least 15 seconds. Only after resuming the passive expression the pacifier was removed and 150 seconds allowed for response. The second gesture was presented in the same pattern. An assistant who did not know the structure of the experiment scored the video-taped responses. The results showed the neonates imitated both tongue protrusion and mouth opening gestures

Video tape recordings of 2- to 3-week-old infants imitating (*a*) tongue protrusion, (*b*) mouth opening, and (*c*) lip protrusion demonstrated by an adult experimenter (top row)

Meltzoff and Moore argue that the human neonate has the capacity to match visually seen information with his own unseen motor behaviour. They discount the other possible explanations. One is that the experimenter or parents could have reinforced the imitation. To overcome this, the parents were not informed about the details of the experiment lest they practise with their children, and the experimenter's face was closely watched — one test where the experimenter had blinked too ofte was dropped. The other explanatio is that early imitation might be base on innately organised release mecha isms as described by Konrad Lore and Nicolas Tinbergen. Imitation four gestures — not just one — d counts this theory.

The present views on infant dev lopment needs revision in the face this discovery of neonates' abilities.

GENETIC ENGINEERING

Human Hormone Made in Bacteria

RECOMBINANT DNA research, often described as genetic engineering, has been the subject of much public debate. Scientists engaged in genetic engineering have drawn attention to the many useful applications of this technique, while others have conjectured upon the possible hazards and misuse. In a recent testimony before the US Senate sub-committee investigating the need for legislation to control recombinant DNA research, Philip Handler, President of the US National Academy of Sciences made a startling announcement. According to Handler, a group of scientists led by Herbert Boyer of the University of California, San Francisco, USA, and another led by Arthur D. Riggs of the City of Hope National Medical Center, Duarte, California, USA, have succeeded in transplanting a gene into the bacterium *Escherichia coli*, which enables the bacterium to synthesise the human brain hormone somatostatin. As Handler explained to the Committee, a 2-gallon (9 litres) culture of the "engineered" bacteria can make 5 milligrams of the hormone, an amount that would require the brains of as many as 500,000 sheep to isolate. The force of this argument unlikely to be lost on the Committe

Somatostatin is a peptide hormon containing a sequence of 14 amin acids. Roger Guillemin of Salk Inst tute shared the Nobel Prize for med cine in 1977 for determining th amino acid sequence of this peptid The hormone, secreted in extreme small amounts by the hypothalamu inhibits the release of other hormon by the pituitary gland and regulat body growth as well as productio of insulin and glucagon.

A few months ago, Howard Goo man and Bill Rutter at San Francis introduced the gene for insulin fro the rat into *E. coli*. The rat gen however, remained silent, leavin open the question whether the gen of higher organisms can be made t function normally in bacterial cell The question has now been answere in the affirmative.

Because of the unusual circun stances in which this discovery wa announced, the exact manner of th experiment remained unknown f some time. Boyer himself refused discuss his results with reporters unt they had appeared in a scientif journal. The paper has now bee published in *Science*, **198,** 1056, 197

Riggs, Boyer and their collabora tors took advantage of the small siz and known amino acid sequence

omatostatin to chemically synthesise a DNA molecule which codes for this peptide. At one end of the DNA chain they included the code word (base triplet) for the amino acid methionine. The artificially synthesised DNA was inserted into a plasmid, a small circular piece of self-replicating DNA, carrying the bacterial genes for β-galactosidase. The genetics of the galactosidase region of *E. coli* have been extensively investigated during the past 20 years and has led to the well-known theories of gene-regulation first developed by Francois Jacob and Jacques Monod. When the biochemically engineered plasmid was introduced into *E. coli*, these bacteria synthesised a polypeptide chain in which the 14 residues of somatostatin, together with a terminal methionine were linked to a fragment of β-galactosidase. By cleaving the molecule near methionine, somatostatin could be separated.

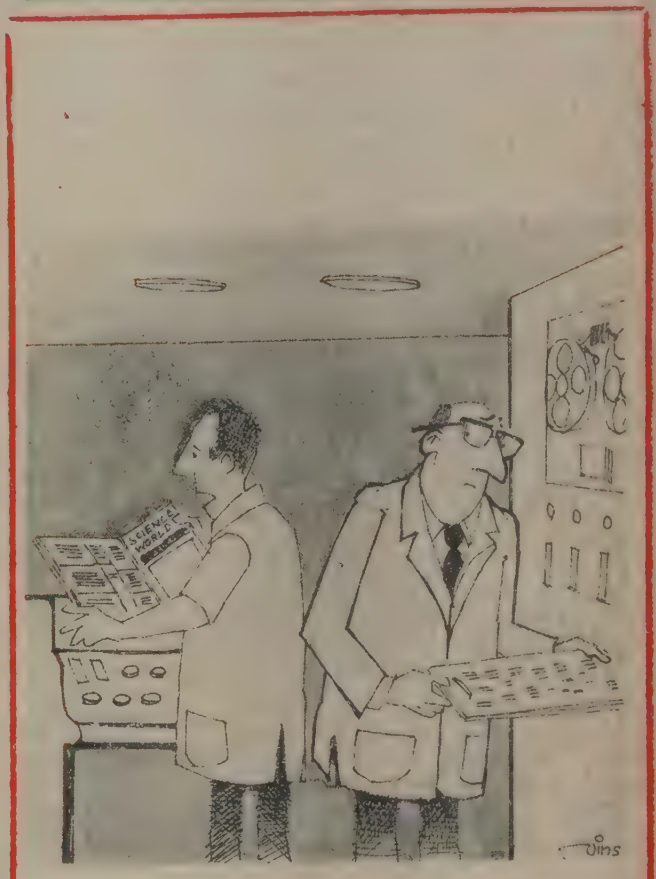
The experiment is indeed an impressive demonstration of the sophistication achieved by gene technology. It shows that the genetic regulatory elements of bacteria can be conveniently employed to control the expression of foreign sequences. Admittedly, in this case, Riggs and Boyer were helped by the small size of somatostatin and the fact that this peptide lacks the amino acid methionine, making it possible to separate the hormone by cutting the hybrid product near methionine.

It is known that the protein chains of higher organisms are often made from precursors which might be different from the final product and these precursor polypeptides are processed by cutting and splicing to give the functional end products. It has been argued that the transplantation of structural genes of regulatory elements alone may not be sufficient to enable bacterial cells to make proteins of higher organisms unless the necessary processing factors are also available. The Riggs-Boyer experiment shows that post-translational processing itself can be engineered.

One may confidently predict that very soon other, perhaps much larger, proteins of higher animals will be made in bacterial cells. Somatostatin may itself not be a specially valuable product from a clinical point of view, but insulin clearly is and there will be many others. There is every reason, therefore, to share the expectation of Paul Berg of Stanford that recombinant DNA " puts us at the threshold of new forms of medicine, industry and agriculture ". Professor Berg, incidentally was also among the first to warn the scientific community of the dangers of careless experimentation in this field.

O. SIDDIQI

[Prof. Siddiqi heads the Molecular Biology Group at the Tata Institute of Fundamental Research, Bombay.]



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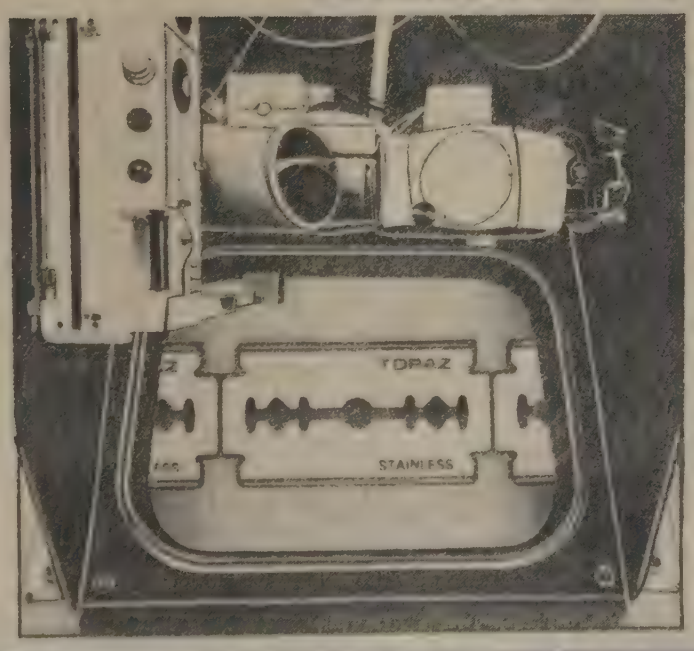

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let's get to know our trees!

THE PALMS

TO the inhabitants of the tropics and the sub-tropics, palm trees are no strangers; in fact, for some, their livelihood depends on the palms. However, even a casual observer (say, from the colder latitudes) would be able to identify palms with ease and place them in a class quite apart from other trees so distinctive is their tall, almost regal, appearance with a crown of huge leaves borne aloft. No wonder the 17th century Swedish botanist Carl von Linné considered the palms as princes among plants and called them *Principes*.

But what is a palm? It's a monocotyledonous plant and a member of the family Palmaceae (or Arecaceae) having some characteristic features: the plant is generally a woody tree straight and tall with no side branches and topped by a crown of very large-sized leaves which are either pinnately divided or palmately notched, each leaf provided with a long, stout and strong petiole (leaf stalk). At the point of attachment to the tree, the petiole expands and embraces the stem and sometimes ensheaths it. The flowers of the palm are unisexual, have floral parts in threes, and appear in inflorescences from the axils of the leaves on thick fibrous stalks — the entire structure is encased in a long, thick, membranous and boat-shaped spathe.

Among the 1,500 odd species of palms in the world, none could vie with the **coconut** (*Cocos nucifera*) for pride of place. The coconut palm is a tall, erect tree, reaching up to 30 metres in its prime. The almost black trunk, which bears the scars of leaves, arises from a slightly swol base from which numerous root emerge. Topping the end of the th trunk is the crown of very la leaves — often referred to as ' frond Each frond is from two to four met long and looks very much like a gia sized feather with its thick cent rib continuing into the stout bla like petiole and bearing one met long thin leaflets. (Palms which ha such pinnate leaves are often refer to as " feather palms ".) Like palms and many other monoco ledonous plants, in the coconut all leaves develop from the single ter nal bud called the ' cabbage '. M people do not get to see this bud b coconut growers and other pa cultivators know that this is most important part of the tree for t tree would die if this bud and apical cluster of budding leaves we removed. Each leaf remains green three years before senility creeps and it drops off.

Through most of the year the co nut bears flowers and fruits. T branched orange-coloured inflo scence (a spadix) covered by a spat arises from the axils of the leaves. Bo male and female flowers are borne the same stalk — the former on end regions and the latter close to base. Male flowers are numero small, sweetly scented and be copious nectar which attracts lar congregations of bees. The fema flowers, on the other hand, are few and larger, and these do not open t the male flowers have withere Perhaps this is a feature which ensur cross-pollination because fema flowers of another tree may be rea to receive the pollen collected by be

(Top, left) A lush growth of coconut tre (Below) Close-up view of a fruit-beari branch and boat-shaped spathes

S. R. N[illegible]

ich come in search of nectar. Wind lination also occurs and, in some cies of palms, may be the more portant method. The coconut gins to flower at about five years.

The coconut fruit is a large fibrous ipe, about 30 cm in length and adly three-sided. The large seed nclosed in a very hard woody shell ich again is encased in a thick mat- g of fibre covered externally by a ooth green skin. It takes about 15 nths for the fruit to mature. The ll contains the white endosperm rnel) which in turn contains a nslucent, sweetish, potable liquid. e pea-sized embryo is located just neath the three " eyes " which can seen on the shells of dried coco- ts; two of these eyes are woody but third is papery thin and it is rough this opening that the germi- ting shoot and root emerge.

A coconut tree is most productive a fruit bearer from about 20 to 70 ars of age, and the average yield r tree is about 120 fruits per year.

Though popular knowledge asso- ates the coconut palm with sea- asts where it grows best, it can also seen cultivated further inland in eninsular India. There is no general greement on the land of origin of the conut which is believed to have been spersed both by ocean currents rrying the buoyant fruits and by e hand of man over the ages. Its ntiquity in India is unquestioned; it as been mentioned in the Ramayana *narikela* in Sanskrit and has been sed since ancient times as one of the fferings in Hindu religious cere- onies. The palm is employed for uch a vast range of uses — so versa- le indeed is the tree — that in ancient ndia it was known as the *kalpa riksha* or tree of heaven. (This is owever, a controversial subject, or the mango tree, and perhaps thers too, have been credited with his title by various scholars.) In learned analysis of the original home f the coconut, P. V. Mayuranathan, ormerly Curator of the Botany Sec- ion, Madras Museum, opines that the oconut must have originated in the ncient Papuan land.

We can cite here only a few of the nnumerable uses of the remarkable oconut palm. The kernel and the rowing embryo are edible; the dried ernel yields the *copra* of commerce nd is the source of a vegetable oil sed for cooking, making margarine, oap and candles. Coconut water is sweet liquid and, besides its thirst- uenching property, is an excellent ineral drink for the sick and convale- cents. Believe it or not, coconut vater, being sterile, has been ad- inistered straight from the nut as an intravenous fluid without any apparent ill effects. The coarse fibre obtained from the husk of the fruit has innumerable ingenious uses — in making ropes, carpets, cables, packing material, rubberised mattresses, etc. Actually, entire industries have developed around utilisation of coir. A sweet liquid (called toddy) thrown up by the cut inflorescences is drunk for its nutritious properties; it is rich in sugar (about 15 per cent) and contains a small amount of vitamin C; the boiled and evaporated juice yields a dark brown jaggery used in local confectionery and cooking. Toddy fermentation yields a liquor and vinegar. The trunks of the coconut palms serve as posts in rustic abodes; hollowed out, they are used as water conduits in villages. Palm leaves are used as thatching material and woven into baskets. The hard shell of the fruit makes a good charcoal. The roots of the coconut palm are used in indigenous medicine as an astringent and as a toothpowder after being roasted and ground.

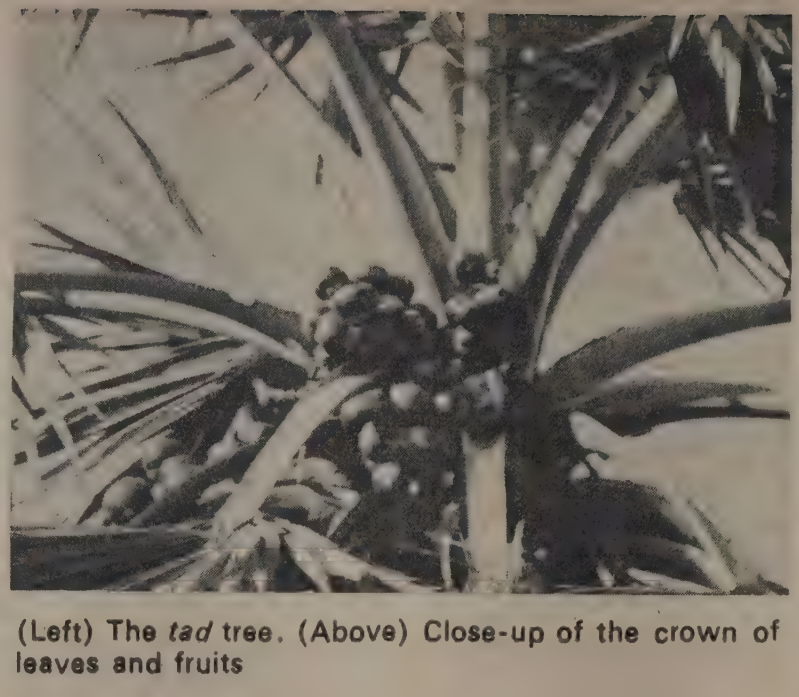
A palm that reminds us of our rich literary heritage handed down through the generations is the **tad palm** (*Borassus flabellifer*), for it was on strips cut from its large leaves that our ancient savants so painstakingly wrote the holy scriptures and their thoughts. References to this palm, *tala* in Sanskrit, have been made both by Valmiki and Kalidasa.

The tad is a tree of good girth and a height of 12 to 20 metres, with a rough, black trunk with marks of old fallen leaves. The crown is made up of about 30 to 40 large, fan-shaped leaves with very thick petioles; the bases of the petioles are expanded, encircle the stem and are closely packed together. The veins from the petiole end radiate outward towards the pointed margins of the palmately divided leaf giving it the appearance of an outsized fan; this palm is, therefore, an example of what are commonly called " fan-palms ".

The tad palm develops its inflorescences from November to about March and clusters of male and female flowers are borne on separate trees. The male spadices of flowers look like large finger-like projections while the female inflorescence looks like a bunch of small dark green

The branching Egyptian doum palm

S. R. Nayak



(Left) The *tad* tree. (Above) Close-up of the crown of leaves and fruits

fruits. Fertilisation occurs by wind pollination. Tad fruits are globular, about 12 to 15 centimetres in diameter and dark purplish black in colour. The soft seed, which is itself quite large, is encased in a hard shell covered with a thick but loose fibrous pulp. This pulp is fragrant and sweet, and forms an article of food; the sweet pulp can be layered and dried in sheets or used for making home-made confectionery. The soft, translucent kernel of the seeds containing a sweet milky liquid is edible and nutritious; one often finds them sold in the local bazars, under the name of *tadgole*, during the summer and after the monsoon.

The tad palm is generally a tree of the coastal belt but, like the coconut palm, one may encounter it much further inland in peninsular India. It is used in much the same way as the coconut palm — the leaves for thatching, mats, rustic umbrellas, etc; the stiff leaf veins bunched and tied together to be used as brooms; the stumps cut from the trunk as house posts, water conduits and the like; toddy is tapped from the inflorescences of both male and female trees.

A good strong fibre can be extracted from the stout leaf stalks; this fibre, known as bassine, is used for making cordage, brooms and brushes. The Warlis of western India make a remarkable wind instrument fabricated from thin bamboo reeds and tad leaves. This musical instrument, called the *tarpa*, has a long horn-like body made by winding long, broad strips of the tad leaf a number of times over. It's quite an experience to listen to the fascinating organ-like notes the *tarpa* can produce!

The tad is often a haven for small creatures. In cavities in its trunk, mynahs and owls may be seen nesting; those small lizards called gekkos, too, find refuge in its cracks and crannies; higher up, palm swifts and ashy swallow-shrikes build their nests in the angles of the leaf stalks; and sometimes the weaver birds colonise many tad palms and construct their pendant nests amid the leaves.

S. R. Nayak

The betel nut palm

Another palm native to our land and mentioned in the works of Valmiki is the Indian wild date, or **khajur** in Sanskrit and Hindi (*Phoenix sylvestris*). The khajur palm is found in the wild state and is also cultivated throughout India up to an altitude of 1,500 metres. Unlike some other species of palms, it is not restricted to the coastal belt. Large tracts of land are often dotted with these palms which grow gregariously along the banks of rivers.

The khajur palm grows straight and true up to 16 metres in height. trunk is rough and bears little regular stumps of the stalks of leaves. It sports a crown of th metre long pinnate leaves with r tively short stiff leaflets each of wh ends in a sharp point. The p grows very slowly and may reac height of just about a metre ten y after seed germination. Dense gro of these date palms often act as de rents to grazing animals (and hike because of the extremely sha pointed leaflets.

As the hot season begins, wild d palms bear male and female infl scences on separate trees and dep on wind pollination for reproduct success. Many clusters of the i (2·5 cm) long oblong, orange-yel fruits ripen during September October. The khajur fruit differs fr the coconut and tad in having a fib less soft pulp; this is sweet and astr gent and, though edible, is mu inferior in quality to the fruits of familiar date of commerce — Persian date (*Phoenix dactylifera*). T seed is ovoid, hard and dee grooved.

The wild date palm is one of best sources of fresh toddy (*nee* Trees are tapped when they about a metre high and yield liquid once a year for 25 to 30 yea The method of tapping this palm neera differs from that employed the coconut and the tad. In t instance, the neera is tapped direc from the soft tissues of the stem making a V-shaped cut in it, and r from the flowering shoots as with t other two palms. If you can go afield you may get a chance to wat a tapping operation in progre it's amazing how the workers co

S. R. Nayak

(Right) A young royal palm showing the typical bottle shape. (Left) Close-up of flowering branch and boat-shaped spathes

S. R. Nayak

he tree to yield up its nourishing quid. Many old trees bear deep cars of these operations without any ietriment to their growth. Toddy ollected in the pots hung up on these rees attract bees and butterflies and lso the nocturnal palm civet (appro-riately named the ' toddy cat ').

Khajur leaves are used as fodder; ts roots are employed in native nedicine as an application for tooth-che; and the powdered seeds are hought to be a remedy for ague. Weaver birds seem to prefer this palm o the others to suspend their nests rom.

Some palms are popular as garden plants because of their rapid growth and impressive appearance; considerations of eco-nomic utility are not important here. An unusual palm which, however, combines all these qualities is the Indian **sago-palm,** or *dirgha* in Sanskrit (*Caryota urens*).

The sago-palm, so called because of the starchy edible substance, *sago*, obtained from the central pith of its trunk, is a tall and erect tree with a smooth grey stem. It is a classic example of a "fishtail" palm — its enormously large bipinnate leaves have leaflets resembling a fish's tail — triangular, with a truncated apex and wavy margin, and one tip some-what longer than the other.

When propagated from seed, it grows rapidly and attains its full height of 12 to 18 metres in about 15 years. Unlike other palms it does not sport a compact crown of leaves; instead, the leaves arise serially from the upper part of the trunk. It flowers throughout the year, bearing both male and female flowers on the same tree, and, therefore, many inflore-scences in different stages of develop-ment may be seen at the same time. Fully developed fruiting branches are sometimes three to six metres long and droop from the trunk. Dotted with hundreds of unripe green or yellow small fruits which turn a deep reddish black on ripening, the ap-pearance of the tree is striking enough to add a touch of novelty to any park or garden usually dominated by its branching dicotyledonous cousins.

(Left) The Indian sago-palm tree, also known as the 'fishtail' palm. (Below) Close view of a large leaf of the sago-palm tree. Note the fishtail shape of the leaflets

S. R. Nayak

The fishtail palm is indigenous to India and is found growing in the wild state in many evergreen forests, especially in the Western Ghats. Its leaf stalk yields a strong fibre, kittul fibre, which has been used as stuffing material, for making brushes and strong ropes; tribal folk used to make bowstrings from these fibres. The fruit is not edible; in fact, it is a strong irritant and stings the tongue if tasted! The acrid pulp is used in folk medicine as an application for headache. A good toddy is tapped from the flowering shoots, and the sago extracted is a fine substitute for the sago — obtained from another palm, *Metroxylon sagu*.

The **royal palm** (*Roystonea regia*) is an elegant tree, imported from its native Cuba and the West Indies as an avenue and orna-mental tree. This palm is also a feather palm with two characteristic features which have probably established its popularity. For one, the trunk, which can attain a height of over 33 metres, is ashen-white in colour marked lightly by pale rings and in full grown trees bulges in the middle to give a quaint bottle-like appearance. For another

the upper part of the trunk is closely clasped and ensheathed by the smooth, glossy green expansions of the petioles so that the tree looks like a gigantic thin bottle with a green neck. It makes quite a pleasing sight when a long avenue or the entire border of a playground or park is punctuated with these tall and out-of-the-ordinary palms, each crowned with an emerald feathery cluster of leaves. This palm flowers the year round, the spadices appearing just below the leaf sheath. It bears fruits, each about the size of a large pea, which turn black on ripening.

Palm trees as a rule are unbranched. But there are a few deviations also. Take for example, the branching **Egyptian doum palm** (*Hyphaene thebaica*). This native of the African continent branches dichotomously, that is, once at the main trunk, then again at each of the two arms of the fork, and so on about three or four times (see photo on p. 25). It is grown in some regions of the west coast of India, particularly at Daman and its environs. Each terminal of the branches has a crown of leaves of its own. The leaf is fan-shaped and palmately divided. Male and female flowers are borne on different trees. The fruit is an ovoid brown drupe about the size of one's fist. Like the palmyra fruit, this fruit, too, has a sweet pulp which is said to taste like gingerbread — hence the palm is also called the gingerbread tree. Doum palm leaves and the strong wood are used much in the same way as those of the palmyra. The inner wall of the seed covering is white and hard; it is sometimes used as vegetable "ivory" for making beads, buttons and the like.

For perhaps over 25 centuries the slender and graceful **betel nut palm** (*Areca catechu*) has been the source of a fruit, known in our epics as *poogaphalam* in Sanskrit, which is an important component of the social and religious rituals of our people.

The betel nut palm is much thinner than those mentioned above and in general resembles the royal palm in the colour of its ringed trunk and the petiolar sheathing at the upper end, but it lacks the bulbous trunk which is straight and uniform, reaching a height of 15 metres or more in well-tended plantations. It is topped crown of closely-packed, dark g pinnate leaves whose leaflets sometimes confluent. From the of the leaf sheath its inflorescc arise from about October to Jan followed by the appearance of bur of fruits. Each fruit is about the of a duck's egg and is green w tender turning to an orange-brow ripening.

The pooga palm is generally c vated on the coastal belt but can grow well further inland up to altitude of 1,000 metres above level.

The kernel of the betel fruit, pc larly called the " betel nut ", is fa hard and brown streaked with p stripes. The betel nut when cu and dried provides the most comr ingredient, known as the *supari* the popular Indian masticatory p paration called *paan* — prepared w betel nut shavings, mixed with ve table spices, flavours and lime, wr ped in " betel leaves " obtained fr a climbing plant, *Piper betle*. (Des the similar name, the betel nut a betel leaf do not, therefore, come fr the same plant!)

Raw betel nuts contain enormous amount of tannins and a a toxic alkaloid called arecoli Chewing the raw nuts causes a ch ing sensation in the throat, giddin and stimulation of the brain; curing process reduces these effe through partial removal of th substances.

In Hindu religious rituals and c toms the betel fruit has a prime pla and it is worshipped before commer ing any ceremony. It is considered be one form of the god Ganesha. C auspicious days, betel nuts along w betel leaves are offered by the young to the elderly women as a mark respect; and many a verbal soc contract is deemed settled with t final offering of a supari to each oth

Palms are well represented in o country with a larger number genera and species than this br article reveals. Not all palms a trees, however, for some are ev extensive climbing plants, like t common rattan cane-palm which the source of cane for furniture ar walking sticks.

S. R. AMLAD

Next month:

TREES OF THE COASTAL REGION

The Indian date palm

S. R. Nayak

Plucking: the finest tea is obtained from the young shoots consisting of two leaves and a bud (the bud being the unopened leaf between the first and the second leaf). Plucking below this standard is not encouraged, because the third leaf is considered coarse for making a good tea

TWO LEAVES AND A BUD!

The sharp fluctuations in tea prices, in recent months, both at home and abroad, have once again brought into the limelight our single most important foreign exchange earner

FROM PLANTATION TO TEA-CUP

A hardened and shameless tea drinker, who has for twenty years diluted his meals with only the infusion of this fascinating plant.

— Samuel Johnson

K. K. MITRA

NOBODY knows how exactly, or when, the first cup of tea was brewed. According to folklore, Emperor Shen Nung who eigned over China in 2737 BC, dis-overed the stimulant effect of tea ccidentally when some wild tea leaves ell into his pot of boiling drinking vater. People of China have probably een drinking tea in some form or ther since the fourth century AD. And considering that wild tea grew n many parts of Assam, it is not un-ikely that tea drinking in India, too, as old as in China. The Dutch who ook tea to Europe adopted the Chinese word *t'e*, pronounced "tay". But in India, Japan, Persia and Russia, the word reached as " chah ", the Cantonese name for it.

Up to the early thirties of the last century, the entire requirement of tea for Europe was met by China. When the British East India Company lost its monopoly of trade with Canton it started exploring the possibility of growing tea in India. But experiments with seeds imported from China failed to produce encouraging results. Then came the discovery of wild tea plants in Assam and several tea nurseries sprung up in Upper Assam. Initially, the East India Company held the monopoly of the plantations, but later charters were given to private firms to produce and market tea. Success in Assam led to further experimentation, followed by establishment of plantations in the Dooars and Terai of North Bengal and the Nilgiris of South India. Then on, there has been a steady growth of India's tea industry.

Tea is now our single most important export. The following statistics (1976) give an idea about our tea industry and its importance in our national economy.

Area under tea plantation	3,63,303 ha
Number of tea estates	about 3,000 (excluding " small growers ", i e, below 10 ha, numbering about 10,000)
Production	512 m kg (million kilograms)
Average yield	1,341 kg/ha
Number of labourers	800,000
Estimated internal consumption	285 m kg
Exports	233 m kg
Value of exports	Rs. 273 crores
India's share in world production	33 per cent
India's share in world exports	30 per cent

The tea plant

Tea of commerce is derived from the tender shoots of the tea plant, *Camellia sinensis* (L)O. Kuntze. Three main varieties of this species are recognised, of which the China and the Assam varieties are the more important ones. They differ in appearance as well as in the rate of growth, hardiness and other characters. The China type, which has smaller leaves and a relatively slower growth rate, produces a lower yield of crop. However, it gives more flavoury teas, and being hardier, is more suitable for sub-tropical conditions and for high elevation areas in the tropics where the winter temperature is very low. Since the various types of tea plants intercross easily, commercial plantations raised from seeds represent heterogeneous groups of the main types and their hybrids. Tea planters in India use the term 'Jat' to describe any such group. The 'Jat' names, however, do not have much botanical significance; they are often derived from the names of the tea estates in which the seed of the variety had been originally grown.

The tea plant can grow under diverse conditions of soil, climate and topography; its range extends from

Georgia (USSR, lat. 43°N) to Argentina (South America, lat. 27°S). So long as the soil remains well drained, the plant does equally well on level land and the hill slopes. However, tea thrives best in deep, permeable soils which are acidic in character and are well supplied with plant nutrients. It needs a well distributed rainfall of not less than 1,500 mm per year. Tea grows well in areas where the summer is moist and warm and the winter is not too cold; the optimum range of temperature is from a mean maximum of 29·5°C to a mean minimum of not below 13°C.

The plant can be propagated either from seeds or from leaf cuttings. The more popular of the two methods is vegetative propagation involving leaf cuttings from 'mother' tea bushes selected for high leaf yield, resistance to pests, diseases and drought damage as well as other qualities. In either case, the plants are first raised in the nurseries and then planted out in the field.

In its natural, wild state a tea plant of the China variety can grow to a height of about 3 metres, and an Assam plant to about 18 metres. In commercial plantations the objective is to keep the plants continuously in the leaf-producing stage, delaying the production of flower or seed in order to ensure the maximum crop. To achieve this, the plant is trained to grow as a low, spreading bush of about two metres height by subjecting it to periodic cycles of pruning of different severity.

Pruning, plucking and the other practices of bush management, such as manuring, control of diseases and pests, use of shade trees and maintenance of proper drainage have to be followed meticulously to ensure high crop yield throughout the entire economic life span of the tea bush, which is normally around 50 years. The crop which constitutes the raw material for manufacture of tea normally consists of two young leaves and an unopened leaf bud — the famous 'two leaves and a b formula — but plucking of lo shoots containing three or even leaves is not uncommon. The pluc round and the length of the har ing season vary from region to re and depend mainly on the clim factors like the rainfall pattern, ten rature of atmosphere and soil and number of hours of sunshine per In Assam, plucking is usually don intervals of 7 to 10 days and the sea lasts from March to November.

Processing

The manufac of tea, as it is practised today, specialised operation involving plication of modern methods biochemical engineering. The fres harvested tea shoots can be proces into one or more of the various ki of tea, namely, black tea, green oolong tea or instant tea. In manufacture of black tea, the mate undergoes the so-called "fermen

BIO-ENGINEERING OF MANUFACTURE OF BLACK TEA

Process steps	Main objectives	Method	Machinery & installation	Changes brought about
Withering	Partial dehydration of shoots (about 75 per cent moisture) to make them leathery for rolling; chemical changes	Exposure to air under natural or controlled conditions	Withering lofts/drums/ tunnels/troughs; continuous withering machine	Lowering of moisture co tent to about 55 per cer increase in caffeine, solub sugars and amino acid changes in proportion organic acids and activi of leaf enzymes
Rolling	Rupture and distortion of tea shoots to allow mixing of enzymes and substrates	Mechanical bruising, tearing, cutting, crushing, breaking and twisting	Crank Roller C.T.C. Machines; Rotorvane; Triturator; Barbora Leaf Conditioner; Continuous Roller	Shoots cut and twiste cellular constituents mixe oxidative changes set in
Fermentation	Chemical changes of leaf constituents by enzymatic oxidation	Exposure to air under controlled temperature (about 30°C) and humidity	Fermentation floor/ tray/trough / drum; Continuous fermenter	Colour changes from gree to coppery; polyphenol bodies oxidised and con densed
Drying	Stoppage of fermentation; dehydration to ensure keeping quality of product	Exposure to blast of hot air in a counter current dryer (Inlet: 80-100°C. Exhaust: 50-55°C)	Conventional Tea Dryer; Tocklai continuous dryer; Fluid bed dryer	Moisture reduced to abou 4 per cent. Product attain characteristic colour an appearance; some sugar caramelised; polypheno undergo epimerisation

Tea leaves after plucking

tion", while in the production green tea, fermentation is purpose eliminated. Oolong tea is a produ which receives an intermediate trea ment and is considered to be "sem fermented tea". "Instant tea" is dehydrated product which contai all the soluble constituents of tea, b from which the insoluble portions ha been removed.

In the manufacture of black te the tea shoots and their constituen undergo various physical an chemical changes. The processin basically involves "withering" partial dehydration of the shoo followed by "rolling", "ferment tion" and "drying". The bio-enginee

The purpose of withering is to reduce the moisture content in the leaves, so that they become flaccid — an essential condition for the next stage (rolling) in processing

ng data on the steps in processing re furnished in the table (p. 30).

Over the centuries there has been great deal of sophistication in the echnology of tea manufacture, but the rocessing still continues to be by the atch system. Research is under way or developing a continuous system of ea manufacture which would provide avings in labour, power, space, time nd costs.

Fermentation is the most important tep in the processing of black tea. resh tea shoots contain about 25 per ent solid matter, nearly half of it as nsoluble substances like crude fibre, ellulose, protein and fats. The water-oluble portion contains, apart from affeine, about 30 different polyphenolic substances, a number of amino cids, sugars and certain organic cids. Within the leaf, but spatially eparated from the polyphenolic odies, there are the polyphenol xidases. The aim of fermentation is o bring about a series of enzyme-atalysed reactions by bringing the olyphenolic bodies (mainly epigallocatechin and its gallate) in contact vith the polyphenol oxidases under uitable conditions of temperature, umidity and oxygen tension. The hanges undergone by the polyphenols re broadly as follows:

Polyphenolic bodies — (enzymatic oxidation)
↓
Orthoquinones
↓ — (dimerization)
Bisflavanols
↓ — (condensation)
Theaflavins
↓ — (condensation)
Thearubigins

The concentrations of the yellow-coloured theaflavins (TF) and the red-and-brown thearubigins (TR) in the manufactured tea have remarkable influence on the colour, strength, brightness and briskness of the tea liquor. The proportion of TF and TR can be brought to an optimum level by proper control of the conditions of fermentation.

The manufacturing process which uses conventional crank rollers for the distortion of tea shoots is known as the orthodox process and the product is called *orthodox tea*. One of the non-conventional equipment available for distortion of tea shoots is the Cutting, Tearing and Curling machine ('CTC machine' for short). Tea manufactured with this machine is known as *CTC tea*. Since the nature and extent of distortion of tea shoots influence the appearance and certain liquoring properties of the end product, the characters of CTC teas are distinctly different from those of orthodox tea.

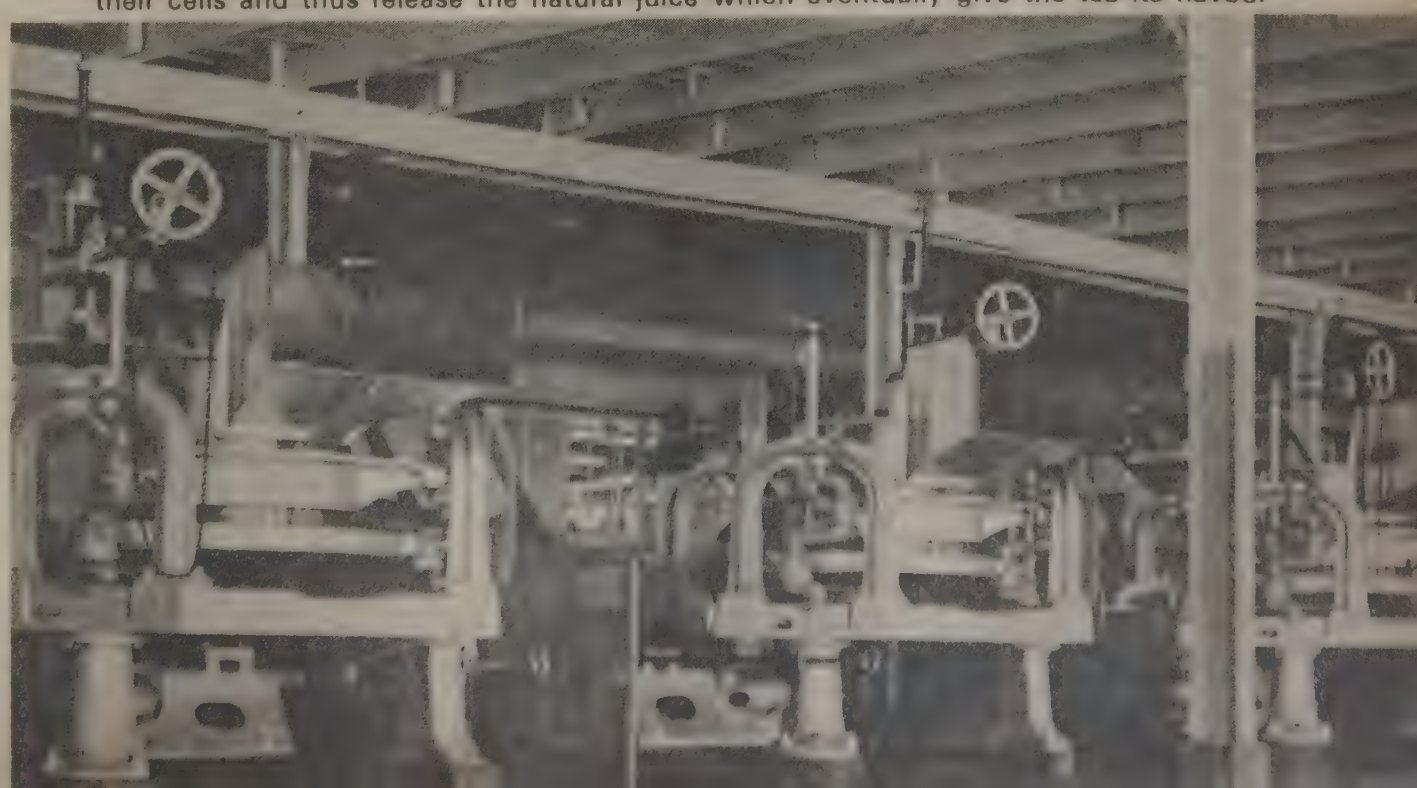
In the production of *green tea*, fermentation is completely eliminated by inactivating the oxidising enzymes by exposure of the tea shoots to dry or moist heat prior to rolling.

Manufacture of *instant tea* — black or green — basically involves extraction of the water soluble constituents of the fresh tea-leaf or the fermented leaf mass followed by drying of the clarified extract in a spray dryer, drum dryer or a freeze dryer.

Grades

The manufactured tea undergoes sorting and grading, which also involve cutting of the coarser material into smaller particles and removal of stalk, fibre, fluff and foreign materials. The products are classified basically into leaf grades, brokens and dust. Each of these main grades is further classified into a variety of size grades bearing names which follow the system of nomenclature prevalent in the particular tea producing area. These are, for example, the Orange Pekoes (O.P.), Broken Orange Pekoes (B.O.P.), Fannings and so on. But the grade names are somewhat arbitrary and are not directly associated with the quality of the products in the trade sense. In fact, we do not yet have any objective definition of quality in tea. The term as used by the professional tea tasters is perhaps a summation of the various attributes by which they assess the market value of tea. One such attribute is the appearance of tea in the dry leaf form, namely, its colour, evenness of size, twist, freedom from stalk and fibre and so on. A "stylish" tea, for example, has leaf of superior appearance and contains golden or silvery particles known as "tips". Another important attribute is the character of the tea liquor produced by brewing the leaf under standard conditions. This includes the colour, brightness, briskness, strength, aroma, flavour and other characteristics of

After withering, the leaves are fed into 'rollers', which twist the leaves and also break up their cells and thus release the natural juice which eventually give the tea its flavour



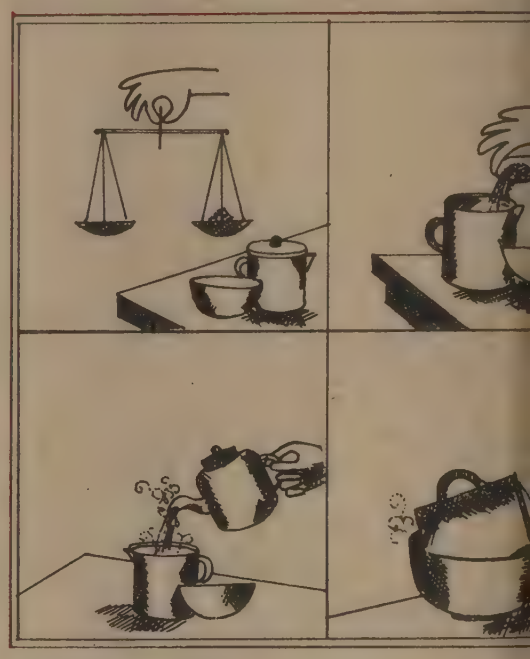
After rolling, the leaves are spread out on glass or cement tables, and allowed to ferment, ie, the rolled leaves absorb oxygen. This is the most important stage, and is responsible for the characteristic colour, strength and the mellowness of the brewed tea

TEA IN N

THERE is hardly any d
that is not a food, too, in t
of the calories it contrib
Tea is no exception. Apart from
milk and sugar generally added,
liquor contains marginal quant
of vitamins and minerals. Its
calorific value makes it useful in
for the obese, and its low sodium
" salt-free " diets.

What you are getting from
daily " cuppa ", however, is diffi
to define in everyday terms, bec
the chemical composition of the
liquor varies with the type and q

TAS



A taster's tools

' Degustibus nonest disputandum '
Latin for, ' there is no disputing
tastes '. To satiate all tastes, th
teas with a variety of flavour
geographical location of the plan
bush genetics, agricultural practi
manufacturing techniques — all
their own specific influence on tea
again, climatic conditions, not
the region, but also the day-to-d
even hour-to-hour atmospheric c
significantly affect quality; tea
factured on an estate in the m
may well be quite different fro
produced in the afternoon or the ev
A tea taster's palate evaluates
countless varieties of tea to ensu
the right cup reaches the right con

A taster's palate and olfactory
are finely sensitive and highly
minatory. These are endowme
birth — it would be true to sa
tasters are born and not made.
natural talents, however, have
trained and developed by long ye
practice before the palate is pro
enough to register the mi
differences.

A taster begins by examinin
processed tea leaf. The make and

the liquor. The taster's appraisal also takes into account the colour and brightness of the infused tea. The entire assessment is based on sensory evaluation. However, since correlation between the chemical composition of tea and its quality is yet to be established, the taster's judgement continues to be the only criterion for evaluation of the quality of tea and its market value. (See box on pp. 32-33).

A chemical definition of tea has been laid down in the Prevention of Food Adulteration Act of India. The characteristics included in the definition and the limits prescribed are: total ash — 5 to 8 per cent; water soluble ash — not less than 40 per cent of total ash; acid insoluble ash — not more than 1 per cent; alkalinity of soluble ash — 1·0 to 2·2 per cent as K_2O; and, crude fibre not more than 17 per cent. Our food law also requires that tea shall be free from added colouring matter. Teas which do not measure up to this specification are considered to be adulterated and are not allowed to be sold either for domestic consumption or for export. This specification is, however, not a quality standard but only a purity standard which helps in detection of spent tea leaf, tea waste and other possible adulterants in tea.

Although a chemical basis is yet to be established, the factors which influence quality in tea are fairly well-known. The genetical character of the tea bush itself and the soil and climatic conditions of the tea growing region are of major significance. Cultural and manufacturing practices also play an important role in optimising quality as well as yield. Tea manufactured in any given tea area, however, shows a seasonal fluctuation in quality. In Assam, teas produced early in the season are of distinctly better quality than the ' rains ' teas or the product of the end of the season. The tea trade tries to iron out these variations and offers to the consumer standard blends of a large variety of teas mixed suitably.

Keeping quality

A well-made tea packed in a standard plywood tea-chest can keep well for nine months or more, provided the temperature of storage is not high. But tea is extremely hygroscopic and under unfavourable storage conditions can pick up a great deal of moisture. Tea with high moisture content ' goes off ' quickly, becomes musty and, finally, mouldy. Cold storage and inert gas packing are used in Japan for preservation of quality in green tea, which usually has poor shelf life.

Next to water tea is perhaps the cheapest beverage in the world and despite the recent steep rise in price it still continues to be so. The price rise has been a cause for concern, but available reports indicate that the tea industry, the trade and the Government are doing their best to ensure that the price of this traditional beverage does not go beyond the reach of the common man.

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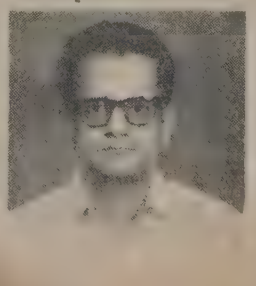


TION...

If the stranger say unto thee that he thirsteth, give him a cup of tea

— Confucius

tity of tea leaf added to the boiling water, the time allowed for infusion and the quantity of milk and sugar added. However, we can assume that boiling water is added to tea leaf in the ratio of 100 : 1 (w/w) and infused for five minutes, when 35 per cent of the solids are extracted. A tea cup contains five to eight fluid ounces. (1 litre = 35·5 fluid oz).

To the non-dieter, the calorific content of tea (or coffee) will be of little significance, but to the calorie-counter it will be of great interest. The knowledge that he is obtaining a small amount of nutriment — enough for energy but insufficient to increase weight — along with his caffeine as a metabolic stimulant when he drinks a cup of coffee or tea can be a tremendous morale-booster for both the obese and the slightly over-weight and possibly encourage them to partake of tea or coffee more often.

The calorific value of tea liquor is difficult to determine with any exactitude. Both the unfermented green and fermented black leaves contain infinitesimal quantities of flavouring oils but no significant quantities of extractable proteins and carbohydrates. Strong British tea (a teaspoonful for the cup plus one for the pot) could afford as many as four to five calories. The American custom of briefly immersing a tea bag in hot water and frequently getting two cups from each little bag would indicate an energy content of approximately one calorie per cup.

Instant tea of two types is available on the market today, and the usage of both for iced and hot tea is growing. One type is identified as " 100% Pure Tea," and a rounded teaspoonful would afford about two calories. The other type, described as " Instant Tea With Carbohydrates " would

S THE TEST

loom or sheen, uniformity and colour, ze, evenness and fibre content of the eaf are checked. Apart from looking t the leaf, a taster may also feel and t times smell the tea.

In the tasting procedure, pots and ups made of the finest china, kept potlessly clean, are used; 2·5 gm of ach tea is weighed into the pots and vater which has just come to the boil poured over it. The pots are then overed with a lid and the tea is infused or either five or six minutes, depending pon the individual taster's preference. Liquor is poured out into a cup and the ea is ready for tasting.

The colour and evenness of the in-usion, as also its ' nose ', are an index o the intrinsic value of the brew. This xamination takes place in a well-lit oom away from direct sunlight, shade nd shadow. Light from the north, vhich is steady and uniform, is ideal.

The scrutiny of the leaf and infusion ver, the taster turns his attention to he liquor and takes a sip from the cup, olls it in his mouth and spits it out. In hat split second, the palate registers the aste — pungency, strength, flavour and ny faults or flaws are all recorded and he taster is ready with his judgement.

As tea is generally drunk with milk nd sugar, these ingredients are, some-imes, added to the liquor to assess hanges in quality due to this interac-ion. Milk also helps to check colour and rightness. The importance of water sed in the beverage is also of import-nce. Different grades of tea give quite different flavours with water from different regions. Experience guides a aster in deciding which tea is best uited for a market and what kind of vater brings out the best in a tea.

In determining the value of a tea, he taster is guided not only by the eaf, infusions and liquor but also by he prevailing market conditions and he demand and supply equation. A lear and sound understanding of the market trends, therefore, is a must. An intimate knowledge of manufacturing techniques is also very necessary to pinpoint deficiencies, if any.

It is believed by many that a taster, to protect his palate, leads a rather austere life — that he eats only spiceless, bland food and does not smoke or drink alcoholic beverages. It is also the belief of a few that a taster dies young. In fact, there are no dietary or other restrictions for a taster. He leads a normal life. His years are certainly not shortened by tasting! One can only presume that these stories were spread by some tasters themselves to scare away competitors.

At least some of the chemical changes that take place during manufacture have been understood. But, chemical analysis apart from being a laborious, time consuming and expensive operation, does not opine on the taste which, to the consumer, is of paramount importance. After all, it is only a tasty cup that cheers, and taste is perceptible only by the human palate.

VIJAY DUDEJA

[Mr. Dudeja (37) is a tea-taster and managing director of a tea concern in Calcutta.]

Tasting of tea is done by planters, to compare it with similar tea produced by competitors, and also by brokers, on behalf of the gardens, before the buying stage

furnish about five calories when a rounded spoonful is used per glass.

Hot tea (or coffee) affords more calories than iced tea (or coffee). Since calories are units of heat, at the level of the calorific value of tea and coffee, the sensible heat of a hot drink is just as valuable to the body as the insensible heat derived from its nutritional value. Thus, if a glass of hot tea containing 200 ml at 60°C is drunk, it affords the body four calories of sensible heat in addition to its one or two nutritive calories. On the other hand, if the same quantity of iced tea at 0°C is consumed, this represents a negative calorie consumption of eight calories which is subtractible from the nutritive food consumption. Other factors, however, such as humidity, temperature, activity and comfort usually determine the relative consumption of cold and hot beverages. A cup of tea containing a tablespoonful of milk and a lump of sugar (25 calories) yields about 40 calories. Thus, six cups daily with milk and sugar, would give you about 240 calories. A cup of black coffee affords 11 calories and a cup of milk, 107 calories.

The carbohydrate content of unprocessed Assam tea is 31 per cent (dry weight), mostly contributed by crude fibre (cellulose and lignin) with sugars, starch, pectins and pentosans. Only four to five per cent of the solids are extracted by hot water, allowing tea to be used in low-calorie diets.

TABLE I: GENERAL ANALYSIS OF INDIAN TEA
(g/100 g)

	Green	Black
Protein	25·55	22·60
Sugar	4·67	4·90
Caffeine	3·06	3·51
Ash	5·39	6·07

Proteins constitute about 22 per cent of the dry weight of black tea but less than two per cent is in soluble form. With a daily intake of five or six cups (6 fluid oz./cup) the protein intake from tea alone is unlikely to exceed 70 mg/day, whereas an average man needs 60–70 gm of protein/day. Milk in tea contributes significant protein and although the casein reacts with the polyphenols of tea, reducing its astringency, this does not hinder the digestion of proteins. Lipids constitute two to three per cent by weight of unprocessed and black tea, but the quantities extracted into water are probably negligible.

TABLE II: VITAMIN CONTENT OF PROCESSED TEA
(on dry weight basis, mg/100 g)

Source	Quality	Thiamin	Riboflavin	Niacin	Folic acid	Pantothenic acid
Darjeeling	Black	175	1,257	6,200	10,700	1,419
Jalpaiguri	Green	207	1,926	5,200	4,500	825
South India	Black	148	1,652	6,400	9,300	1,967
Assam	Black	173	1,207	7,100	6,600	1,160

Vitamins

Tea is fairly rich in some of the B-group vitamins (Tables II and III). The riboflavin content of processed tea is fairly high and well comparable to that of some rich sources like roe, beef, liver and fresh yeast.

Studies by D. N. Das and others (*Scientific Publication Series, No.* 1, **3**, 1964, *Tea Board*, 1957) have shown that the contents of thiamine (vitamin B_1) and riboflavin are always significantly lower in tea prepared from plants grown under shade, compared to those from plants grown unshaded.

It has been noted that the maximum amount of riboflavin occurs in the second leaf and the lowest in the stalk portion. The riboflavin content of tea leaf is significantly lowered during its processing.

The substantial amount of riboflavin in tea has led to suggestions about its place in the diet of the aged. Riboflavin is thought to provide the maximum extension of that period lying between full adult capacity and the encroachment of old age. Assuming the daily adult requirement of riboflavin to be about 1·8 mg, a person taking five cups of Indian tea daily (corresponding to about 13·1 g of tea) would obtain 9 to 14 per cent of his daily requirement of the vitamin, exclusive of those provided by milk.

Green tea in general contains a higher amount of riboflavin than black tea and therefore the former is nutritionally more desirable.

The niacin value of tea is fairly high and is well comparable to sources like leaf, kidney, fresh ham, chicken, whole wheat flour and barley flour. The niacin content of tea (Table III) is highest in the bud and least in the stalk. The niacin content decreases significantly in green tea, probably during the roasting (blanching) operation of the leaf done by immersion in boiling water. About five cups of tea per day contribute about 5 per cent of an individual's daily requirement of niacin, assuming that 90 to 95 per cent of the vitamin is extracted under home conditions of preparation.

The folic acid content is higher in black teas than green teas, particularly Darjeeling black tea. Similarly with pantothenic acid.

Golyanitskii and Bryushkova in 1936 demonstrated the efficiency of Russian green tea in curing various vitamin C (ascorbic acid) deficiency symptoms. (Russian green tea contains 0·18 mg vitamin C per gram compared to 0·07 mg/g in Indian tea.) Vitamin C is significantly reduced during manufacture of black tea; it is oxidised and decreased at all stages of manufacture, mostly during 'firing'. Fresh tea leaf, as a source of vitamin C is comparable to other rich sources like the adrenals, liver, heart, orange and lemon. Unprocessed and green teas contain vitamin C in amounts comparable with lemon and liver, but this is almost entirely consumed during the fermentation stage of black tea manufacture. Vitamins E and K occur in the lipid fraction of black tea. Vitamin E (α-tocapherol) is particularly prevalent in Ceylon and Indian teas. Tea apparently is a good source of vitamin K, though 30–50 per cent is lost in black tea manufacture. It occurs at a level of 300–500 I.U./g in Russian black tea; indeed, tea is used clinically in the USSR to increase the prothrombin level in children suffering from deficiencies of this blood coagulant. Five

TABLE III: DISTRIBUTION OF B-VITAMINS IN TEA SHOOT
(mg/100 g)

	I Thiamin	II Riboflavin	III Niacin	IV Folic acid	V Pantothenic acid
Bud	144	1,050	86	47	1,050
1st leaf	165	1,473	60	77	1,161
2nd „	196	1,591	72	59	1,249
3rd „	110	1,331	66	27	1,386
Stalk	85	886	52	20	700

cups a day could provide 100 per cent of the vitamin K required.

The β-carotene (precursor of vitamin A) content in tea leaf is comparable to that in carrot, spinach and cabbage at about 13,800 mg/100 g in green leaf and 100,000 mg/100 g in black teas.

Tea contains traces of various inorganic constituents like copper, fluorine and manganese. Traces of copper are essential for the absorption and utilisation of iron within the animal system. McLendon's findings (*Nature*, 1954) with rats on a diet supplemented with tea infusion have shown a significant protective effect against tooth decay; he recommended more tea drinking — beginning on a small scale at the age of one — as a possible preventive against tooth decay.

...AND IN MEDICINE

THE accumulating scientific data on tea and its constituents — the vitamins, the caffeine and tannin — and on its anti-bacterial activity provide a new picture of this popular beverage. Over the past few decades, the list of clinical conditions for which tea is contra-indicated has been steadily decreasing. On the other hand, tea is claimed, among other things, to aid digestion and restore the body's fluid balance. Tea has been apparently used to treat successfully even radiation sickness. But much of the alleged therapeutic value of tea, although recognised by Russian and Indian scientists, has received little attention in the West. Whatever the merit of these claims, one thing seems clear: they do call for a thorough medical reappraisal of tea.

The universal popularity of tea would be difficult to explain were it not for a certain psychological effect. Indeed, it is known that caffeine, one of the important constituents of tea, affects the central nervous system, shortening reaction times and relieving mental fatigue. Using simple reaction time (a measure of alertness) and complex reaction time (a measure of speed of discrimination), Stanley and Schlosberg (*Journal of Psychology*, **36,** 435, 1953) showed that tea significantly quickened both these reactions.

Mode of brewing

Apart from the type of tea and the quantity, the manner of brewing also influences the effects of tea. When four or five grams (a heaped teaspoonful) of leaves are steeped in a cup of boiling water for two to four minutes, the resultant brew contains about 0·1 to 0·15 grams (2/3 to 2 grains) of caffeine. The second infusion contains no caffeine but only some tannin.

In 1939, Halpenny and Dermot (*Canadian Medical Association Journal*, **41,** 449, 1939) spent a month investigating the effects of tea on ten young healthy adults. Three 8-ounce (227 c.c.) cups of a five-minute brew of good tea drunk at 45-minute intervals produced universally pleasurable effects, whereas a 10-minute brew produced distaste with slight nausea. The addition of milk and sugar to the stronger brew eliminated these unpleasant reactions. With a cheaper brand of tea, even a five-minute brew produced abdominal discomfort in four subjects. With the 10-minute brew nearly all subjects were nauseated and many complained of abdominal discomfort.

Three minutes after pouring boiling water on tea, most of the caffeine has been extracted and the caffeine/tannin ratio is at its highest. None of the reports on tea deny its effectiveness in the relief of fatigue. Depending on the results desired, tea may be prepared to be mild, allowing sleep, or it may be prepared robust and a true stimulant.

There is a long-held belief that a cup of tea after meals facilitates digestion and diminishes the distress after a heavy meal, said to be due to decrease in gastric motility. Halpenny and McDermot (1939) compared the relative effects of alcohol, tea and hot water on digestion and found that tea had no constant effect on peptic acidity; it did not stimulate acidity any more than hot water alone. The diuretic (promoting urine secretion) effect of tea was found to be 1·55 times greater than a similar quantity of water. Gastroscopic examination of these subjects, who had completed their month of experimental tea-drinking revealed a mild superficial gastritis with slight reddening of the gastric mucosa.

Should tea be given to children? Most physicians as well as mothers would exclude caffeine from children's diets. Perhaps this policy requires revision. Whitacre (*Journal of Home Economics*, **34,** 87–192, 1942) studied the energy metabolism of a group of children aged 10 to 13 over a period of three hours following ingestion of medium-strength tea (caffeine content, 0·03 mg per cup). He found the resulting metabolic stimulation to be practically the same as that following the drinking of lemonade.

It has been firmly concluded by Wirts and others (*Journal of the American Medical Association*, **155,** 725-29, 1954) that tea need not be contraindicated in the treatment of most gastro-intestinal conditions. In cases of vomiting and diarrhoea, tea can restore the natural fluid balance. More and more it is being realised that tea can provide a gentle, yet fairly sustained boost to the convalescent patient and to the mentally depressed patient.

Caffeine

The constituents of tea which react principally on the psychic centres and the palate of the tea drinker are mostly the xanthines and tannins.

Tea contains all the three methyl xanthines — caffeine, theobromine and theophylline. The principal of these is caffeine (which is also found in coffee and cacao), the content of which in processed tea ranges from 1 to 5 per cent. About 80 per cent of the total caffeine is extracted in the first brew of a five-minute infusion. A cup (227 cc or eight fluid ounces) of medium tea contains about 96 mg caffeine. The daily consumption of caffeine from 5 or 6 cups of tea would be 0·5 g. The British Pharmaceutical Codex allows a dose of 0·5 to 10 grains (32 — 648 mg) per head daily as tolerable limit.

Caffeine, theobromine and theophylline are similar in their pharmacological properties but differ markedly in the intensity of their action upon various organs and tissues. Caffeine is considered to act on the central nervous system, on muscles, including cardiac muscle, and on the kidneys.

The action on the nervous system is to stimulate the higher centres. The ability to interpret sensory impressions is increased. Thought becomes clearer and more rapid, mental fatigue is relieved and the reaction time is shortened. With a large dose of caffeine, the action extends from the psychological areas to the motor areas, the medulla and the cord, and the patient becomes at first restless and later may show convulsive movements.

The felicitous psychic effect of tea is no doubt produced by caffeine but somehow caffeine's less desirable effects seem to be absent in the well-brewed cup of tea. One explanation of this seeming paradox is that caffeine and tea tannins react antagonistically

(Continued on page 39)

Atmospheric humidity is extremely low during February and March; hence tea cuttings in nursery beds, have to be sealed under a polythene cloche

TEA INDUSTRY IN SOUTH INDIA

Owing to the markedly different agro-climatic conditions and the existence of many small growers, the tea industry in South India has its special problems

C. S. VENKATA RAM

TEA cultivation in South India commenced only towards the middle of the last century and was initially on small scattered individual holdings. Until around 1880, investments on plantation crops in South India were mainly in coffee, but in the wake of the deadly coffee leaf rust disease which caused devastation to the coffee industry, there was a marked swing to tea investments, as reflected by the progressive increase in the planted acreage. Much of the initiative to this expansive phase of the tea industry in South India is attributed to large business houses in Great Britain, hence, historically, tea planting on commercial scale has a direct bearing on the corporate structure of the industry. Between 1927 and 1932 the area under tea in South India increased from 34,000 to 48,000 hectares and at present the figure is just over 74,000 ha. The industry provides livelihood to almost 20 lakh persons, directly or indirectly, with direct employment on a ratio of 2·5 workers to one hectare. Productivity of tea in South India, roughly 1600 kg/ha at present, is the highest for any major tea growing region in the world.

Tea is a sub-tropical plant with one essential requirement for cultivation on commercial scale, namely, acid soils. Soils where tea can be initially established successfully must be acidic, with a pH below 6·0 and such soils in South India occur only on the hilly slopes of the Western Ghats, the Nilgiris and on the high plateau north of the Nilgiri mountains. The second requirement for commercial tea cultivation is adequate rainfall; if well distributed throughout the year, between 100–120 cm of annual rainfall will support successful commercial tea culture, but if concentrated in certain periods, such as the south-west monsoon, the north-east monsoon, or both, 150 cm of annual rainfall would be the minimum requirement. The soil type is not important because, whilst tea is grown on commercial scale in South India in lateritic soils, in north-east India, tea gardens predominantly occur in tracts of alluvial soils.

Since tea can grow only in acidic soils, this has resulted in the tea industry in South India becoming concentrated in the hilly tracts of the wet and lush Western Ghats, and the Nilgiris. This has meant clearing of forests and opening of tea estates in uninhabited areas. Thus, from a socio-economic point of view, specific land utilisation for a commercial crop provided employment in many cases to tribal people and led to their social and economic development. In sharp contrast, tea in North India is cultivated mainly on the plains where paddy, sugarcane, or other commercial agricultural crops, could also be grown; the only exception would be Darjeeling where the agro-climatic conditions are similar to those in the hilly tracts of the Western Ghats and the Nilgiris in South India.

Sharp differences

Apart from the marked differences in land terrain and soil types of the tea areas in North India and South India, there are other sharp differences, one of which pertains to the latitude and its concomitant day length periods. In South India the tea areas fall south of 12·5°N, whereas in North India tea is grown between 24° and 28°N latitude. The diurnal variation in South India in terms of day length is marginal as between seasons and at no time does the day length fall below 11 hours — a day length of 10·5 hours is considered critical for active vegetative growth to occur on tea plants. In contradistinction, the day length in the tea areas in North India fluctuates widely from 10 hours to about 13 hours. Thus, whereas tea grows all round the year in South India, in North India the growth almost ceases between November end and early March. On account of these differences, tea production in North India is restricted to the part of the year between March and November. However, the extra day length obtained in North India during July–September is a factor contributing to high productivity during this period, while paradoxically productivity is extremely low during this period in South India because of excessive wet conditions and low sunshine.

Another important difference in climatic conditions relates to temperature which in South India is relatively low because tea is cultivated on hilly tracts where the elevation is generally 1,000 m and above. In the North, the temperature is in the high nineties during the summer on the plains, a temperature which is unfavourable for high tea productivity. Hence, a good stand of shade trees to provide a over-hanging canopy is essential for reducing leaf temperature and for optimising productivity of tea in North India. In the South, shade trees are planted for other reasons, not essentially to reduce the temperature on the bush surface.

The third important difference

between the tea areas of North and South India lies in variations in atmospheric humidity. While in the case of the former, the relative humidity of the atmosphere is high, above 60 per cent throughout the year, in South India it falls to as low as 15 per cent in February and March. This necessitates adoption of specific techniques for protecting the tea plants against desiccation, for instance, by sealing of nursery beds with polythene cloches (covers) when cuttings are raised. If vegetative cuttings of tea earmarked for propagation are not sealed under polythene tent, in the very dry period they will perish. From this angle it is much easier, and cheaper, to raise vegetatively propagated tea plants in North India compared to South India.

While the tea plant is botanically classified as *Camellia sinensis* L. (O. Kuntze), it is essentially a hybrid of three distinct species. Of these, the China and Assam types are two contrastingly different species, the former a small bush having very small leaves, while the Assam type has large leaves and grows as a tall plant. The commercially cultivated tea plant in South India is a Assam-China hybrid with medium-size dark leaf. On the other hand, in North India the tea plant is a large and light leaved Assam type of bush; the exception being Darjeeling where small-leaved China type of tea plants are cultivated commercially.

Differences in cup characters

With the exception of the Darjeeling teas in North India, and teas grown in the Nilgiris and in restricted areas at high altitudes in South India, which are known for their aroma, all other teas are sold for other cup characters such as briskness, strength, body and brightness. An important sale criterion for South Indian teas is the appearance of the black tea; the blacker the colour, the higher it is valued. North Indian teas, in contrast, are neither marked up or discounted for their colour. Consequently, the manufacturing technology is tailored to suit specific requirements in the two regions, although the basic manufacturing process remains the same in both North and South India.

The teas produced on the Nilgiris in South India, and in other parts at high elevations in Kerala, are comparable to the teas produced from Darjeeling, since both are manufactured by the orthodox process and with focus on aroma development. Both Darjeeling and Nilgiri teas fetch high prices mainly for their flavour, although the muscatel flavour of Darjeeling teas is unique in itself. The other Assam and Bengal teas in North India are known mainly for their full-bodied liquor and strength; similarly the majority of the tea produced at mid-elevations in South India has a brisk and bright liquor.

In the earlier years tea in South India was manufactured mainly by the orthodox method of rolling which produced bright and brisk liquors with little strength. The Legg Cut machine was also employed in many tea factories until the fifties of the present century and teas produced by the Legg Cut process were bright with good strength. A noteworthy change took place in processing technology with the introduction of the CTC (Curling, Tearing and Cutting) machine and this is now used for the bulk of tea manufactured at mid-elevations in South India. CTC teas are thick liquoring and brisk, they are economical to the housewife as relatively less of the leaf is required to brew a cup; therefore they are popular with the average tea drinker in India who is not particular about flavoury teas. Other variations to obtain thick liquoring teas are the use of the Rotorvane and the Lawrie Tea Processor. Essentially, then, in the Nilgiris and at

GREEN TEA

To the drinker of black tea, green tea will hardly seem to be tea, especially if it is Chinese tea, which is drunk without milk. The liquor has a raw greenish appearance and is lighter (Assam green tea is more brownish than Chinese green tea). Indonesian green tea is scented by mixing with various flowers like jasmin. Green tea consumers in North Africa have a strong preference for sugar and flavour additives like mint. Besides being rich in vitamin C (see p. 34) green tea has been found to have therapeutic properties.

The two main kinds of tea, black tea and green tea, have been evolved by varying the conditions of drying of fresh green leaf. The main difference in the method of processing is that in the case of green tea, every precaution is taken for retaining the green colour and the chemical make-up of the tea-leaf. Even in the very early days, the initial heat treatment of the leaf was adopted as the basic step in manufacture. With the advancement of technology, the method of heat treatment assumed several variations, such as cooking in open pan, application of dry heat in a closed vessel, dipping in boiling water and exposure of the leaf to free flowing steam. The methods in different countries have taken distinct forms to suit the preference of their respective buyers at home and abroad. Broadly, the methods may be classified under two distinct heads, i e, the Japanese method and the Chinese method.

High quality green tea requires tender leaves and freshly plucked buds from tea bushes of the China type, botanically known as *Camellia sinensis* var. *sinensis*. The greatest care is needed during handling, transportation and storage of the green leaf prior to manufacture, as bruising and excessive heating of the leaf immediately encourages fermentation and microbial infection. Even the slightest fermentation at this stage affects the liquor, which becomes cloudy.

In the Japanese technology, the freshly plucked leaves are steamed for at least two minutes in cylindrical drums. This heat treatment inactivates the oxidising enzymes of the leaf, fixes the green colour, eliminates its raw smell and gives the leaf the elasticity required for the next step of rolling. This is followed by drying in a rotary drier. When the product is dried, it is passed through the twisting machine, where the rolled and partially dried material is rubbed against a hot plate which gives it a flat, smooth and silky texture. Final drying is carried out in an endless chain drier.

In the Chinese method of manufacture, the green leaf is kept in a cast-iron pan and turned with turning forks for about 10 minutes to destroy the oxidising enzymes. In Russia, this is done in the steaming machine, an endless chain of trays encased in a closed chamber, into which steam under pressure is passed.

In the Indian practice, the rolling is done in a conventional roller (unlike the Japanese process in which rolling is done in a drum with a central rotating shaft to which sweepers and forks are attached). The second roll is without pressure, which gives the leaf an attractive twist.

The Chinese type of green tea is usually offered for sale after polishing and colouring. For polishing, french chalk or gypsum may be used and for colouring, indigo.

The average annual production of green tea in India has been of the order of 7 million kg. More than half of it is consumed internally and the rest exported, mainly to Afghanistan.

Consumers generally prefer green tea the dry leaf of which has a bright olive green colour with no trace of brown or red.

P.K.

high elevations in Kerala tea is manufactured by the Orthodox method with every care to accentuate flavour; in the rest of the areas at mid-elevations, up to 1,500 m above sea level, roughly half the tea is manufactured by CTC process and the rest by the Orthodox process. In this respect there is a fair comparison between North India and South India, barring, of course, Nilgiris and Darjeeling. In North India several of the tea factories are fitted with dual processing system so that they switch over to CTC; or the Orthodox manufacture, to suit market demands — this is a feature lacking in South India.

The fact that tea is harvested round the year in South India and that it is grown under relatively cool climatic conditions, dictates specific agricultural practices for tea cultivation suited to the region, in contrast to agronomic techniques in North India. One of the main differences is the pruning cycle of four to seven years in South India, while in North India generally the tea is either skiffed or pruned every year, albeit in the last few years there is a certain tendency to run the tea for a second year, unpruned. As there is a long dormant period in North India, tea can be pruned or skiffed during this period and with favourable weather conditions in March/April the recovery is rapid. On the other hand, since the tea bush is cropping all round the year in South India it is pruned only when the productivity levels off, or the bush height increases to such an extent that plucking becomes difficult. The longer pruning cycle in South India causes the harvestable tea shoots to become progressively more fibrous, hence the waste percentage is considerably higher than in North India where highly succulent shoots are harvested from tea that is skiffed or pruned annually, or once in two years.

As tea is grown on mountain slopes in South India, the plucking system has to ensure maintenance of a proper slope, level with the terrain. This is achieved by the use of level sticks by the plucking mazdoor. Slope plucking is essential to economic success of tea cultivation in South India because fungicide sprays have to be applied frequently on the plucking table for the control of blister blight disease and good results of spraying will be obtained only when tea slopes are correctly maintained.

There are two auction centres in South India, the larger and more important one in Cochin and the other in Coonoor. Teas sold in the Coonoor auctions are mainly bought for sales within the country. At Cochin teas are sold both to exporters as well as to those who market it within India. Logistically, Cochin is advantageously situated when compared to Calcutta and other tea sale centres in North India for catering to the export market because the freight is greatly reduced on shipping to the Middle East, United Kingdom and Europe. This advantage is now clearly seen with the reopening of the Suez Canal. Mostly the leaf grades are exported from the Cochin auction centre, such as the Broken Orange Pekoe, Orange Pekoe and Broken Orange Pekoe Fannings. The dust grades are mainly absorbed for internal consumption. The prices of tea bear no relationship to the cost of production and they fluctuate very widely in relation to the market supply and demand position. Interestingly, tea prices in Cochin early in 1977 were very lucrative in comparison to those fetched by teas in the Calcutta auctions, and perhaps one reason for the good prices in Cochin is the saving on freight cost of teas exported to the Middle East and UK markets.

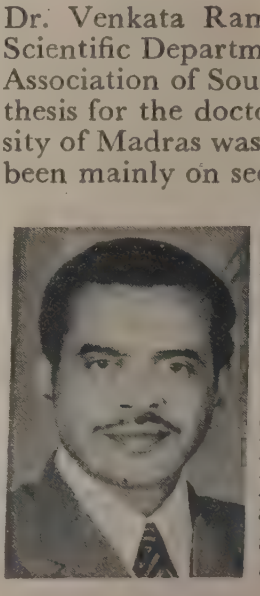
Scientific Research

The industry in South India has been nursed by a Scientific Department run entirely by private membership of tea growers under the control of the United Planters' Association of Southern India. This Department has completed 50 years of service to the Industry, in which period it has witnessed phenomenal productivity increase. Tea production in South India has doubled in the last two decades, which in itself is an expression of the tremendous impact made by scientific research and advances in field technology, directly through the efforts of the Scientific Department. Several break-throughs have been made, such as correction of zinc deficiency, nailing the fertiliser requirements and specific nutrition deficiencies with corrective measures, rejuvenation of unthrifty tea bushes, introduction of high-yielding clonal selections and gearing up plant protection to prevent crop losses caused by pests and diseases. It is worthy of mention here that tea production in South India has doubled in the last two decades on the same acreage, rather on slightly less area than what was under tea 20 years back! This tremendous vertical expansion reflects the highly advanced field technology and crop husbandry in tea in South India.

One distinctive feature, albeit not on a very large scale, is the cultivation of tea in South India by small growers. While only about 10,000 hectares are with small tea growers, their number is just as large, if not larger. There are more than 10,000 registered small tea growers but it is not unlikely that several more remain unregistered. In contrast, there are no small tea growers either in Assam or in Bengal where the bulk of tea is cultivated in North India. The productivity of the small tea holding in South India is approximately 50 per cent that of large tea holdings in the corporate sector. The low productivity on small holdings is a pointer to the organisational strength and systems approach required for optimising tea crops, as obtains in well managed estates of the corporate sector. Efforts are continuing to increase the productivity of the small tea holdings through improved input technology, better knowledge transfer to farm hands and by incentives for planting high yielding clonal material. Several schemes for assistance to small tea growers have been initiated by the Tea Board, the State Government, the Banking Organisation and the United Planters' Association of Southern India to improve productivity in the Small Growers' sector. Indeed, on an area of 10,000 hectares, cultivated by small growers, a generous increase in tea production in South India may be expected.

Practically all the crop increase in South Indian tea has come on the existing acreage. Between 1974 and 1976 the crop increased from 103 million to 112 million kg and it is expected that in 1977 it will touch 130 million kg. However, there is a limit to crop increase on the vertical plane and to meet the future demands of 10, 20 and 30 years from now there will be a need for horizontal development. If our country is to meet the challenges to increase tea production required to supply internal demands and fulfil export obligations, the Land Reform Policies will have to be amended. As long as vertical expansion through continually improving crop husbandry and field technology is pushing tea production substantially every year, it is unlikely that the political eye will focus on the realities of the situation.

Dr. Venkata Ram (50) is Director of the Scientific Department of the United Planters' Association of Southern India since 1974. His thesis for the doctorate degree of the University of Madras was on soil fungi. His work has been mainly on seed-borne and soil fungi and their physiology and control, and on fungicides. He was responsible for the control of blister disease of tea with nickel chloride, and was the first to demonstrate that application of copper oxychloride continually leads to build-up of mite pests on tea. He has authored several research and quasi-scientific publications.



when they meet in a cup of tea. This suggests that much of the insomnia attributed to caffeine may be due to its gastrointestinal effects — effects not present in tea.

Caffeine promotes the performance of muscular work; it increases the rate of respiration but in man it has no effect on the pulse rate. It also promotes urine secretion. Augmentation of gastric secretion and in the stomach following its administration has been reported. Lysanowicz and Kedar (*Annals of the University of Mariac Curie Sylodowska, Lublin, Polonia*, **14,** 181, 1959) showed that caffeine in adequate amounts lowered the cholesterol level in the blood of rabbits. The fatal oral dose of caffeine for humans is estimated to be about 10 g but untoward reactions may be produced by even 1 g.

Caffeine is sometimes prescribed therapeutically for the treatment of hypertensive headaches and tea is a legitimate means of supplying this medication. Tea is also administered as a dietary adjunct in the treatment of angina pectoris and myocardial infarction because caffeine relaxes the coronary vessels and promotes circulation. L. Gould in 1973 (*Journal of Clinical Pharmacology*, **13,** 469) reported that the administration of tea to patients with cardiac disease brought about a significant rise in the cardiac index, stroke index, oxygen consumption and minute ventilation. Tea is also used in the relief of bronchial asthma due to the relaxant effect of caffeine on smooth muscle. The diuretic property of tea is useful in the therapy of cardiac oedema (accumulation of fluid in tissues).

H. Jick and others (*New England Journal of Medicine*, **289,** 63, 1973) found a negative correlation between myocardial infarction and heavy tea consumption. Other workers in feeding trials found habitual tea drinkers to have a lower incidence of atherosclerosis (hardening of blood vessels) than coffee drinkers; tea seems to reduce serum lipid (fat) concentration and hence the incidence of atherosclerosis. Apparently, the caffeine in tea is not harmful, and tea may actually exhibit anti-atherosclerosis activity arising from an unidentified principle. It has been suggested that tea polyphenols (see below) may inhibit the absorption of dietary cholesterol and this appears to be consistent with the synergism between polyphenols and vitamin C which has been shown to lower the cholesterol level in rabbits.

Tea is often denied to hypertensive individuals. The use of tea in average amounts (five 8 oz cups equivalent to 0·39 — 0·49 g of caffeine) is not contra-indicated except in cases of peptic ulcer, labile autonomous nervous system, hyperthyroidism or hypertension, which are said to tolerate caffeine poorly.

FOR THE PERFECTIONIST . . .

You can have a cup of tea simply by throwing some tea leaf into a vessel of boiling water, but that is not how the perfect cup of tea, the tea that's fit for the fastidious, is brewed.

First you must use enough tea, that is, one teaspoonful of tea (or one tea bag) per cup. (For iced tea, use half as much again.)

Use fresh, cold tap water. Water that has been kept standing in a kettle will have lost its tiny air bubbles, and the tea will be flat and insipid. Rinse out the teapot with hot tap water. That will help keep the tea hot as it steeps. Pour the water over the tea leaf as soon as it starts bubbling furiously. Over-long boiling makes the water flat. The golden rule is to bring the teapot to the kettle (not the other way around) and pour with the kettle's spout as close as possible to the teapot. Otherwise, the water temperature will drop fast and the true flavour of the tea lost. Let the tea brew (never boil) for no less than three minutes and no more than five minutes by the clock. Stir and serve. Don't go by the colour, for colour develops before flavour does; it's duration that matters, and if your estimate of three minutes is short by a minute, your tea is likely to be off-flavour.

If you want light tea, don't use less leaf or brew for less than three minutes. Follow the rules for making hearty tea and then weaken it with hot water after the true flavour has been brought out by proper brewing.

Tannins

Next to xanthines, come tannins in pharmacological importance. The tannin bodies, or tea tannin, constitute the major portions of leaf, green tea and black tea. Making up as much as 30 per cent of the dry weight of leaf, tea tannin is not a single chemical compound but rather a mixture of polyphenolic compounds, the most important of which are flavonols. A five-minute brew would give about 30 mg per cup.

The structural similarity of tea leaf tannins or flavonols to the flavonoids (which include vitamin P) had led to the demonstration of vitamin P activity, particularly in green tea. (Vitamin P reduces the fragility and permeability of the capillaries). Russian black tea, unlike Indian black tea, shows appreciable vitamin P activity, probably due to less oxidation of leaf catechins (flavonols) during processing. Das and Ghosh (*Report of the Research Liaison Committee of the Tea Board*, 1963) reported Vitamin P activity of tea infusions or its tannins in rabbits injected with cholera germs; total body fluid dehydration was less, suggesting that injection of green tea infusion or its tannin might be used clinically in the treatment of cholera. In Soviet Russia, tea leaf tannin has given particularly favourable results in the haemorrhagic diseases following massive x-ray and radiation therapy. According to Ershoff and Steers (*Proceedings of the Society for Experimental Biology and Medicine* (1960) the flavonols in green tea tannin have an anti-oxygenic function ; this lowers the concentration of oxygen, whose presence apparently increases the sensitivity of the organism to radiation. The radiation experiments which were conducted at the Bach Biochemistry Institute, in the Ukraine, were inspired by the survival rate of patients in Hiroshima after the atomic explosion. Japanese scientists noting that those who drank tea regularly survived, hypothesised that the tannin content of tea might have somehow neutralised the effects of strontium-90.

The daily administration of tannin preparation of tea leaf or green tea increased the storage of vitamin C in the various tissues in guinea pigs, and reduced the excretion of vitamin C through the urine. This activity, which is absent in black tea, is attributed to the unoxidised flavonols; such work indicated an important role for green tea in human nutrition in preventing some symptoms of ascorbic acid (vitamin C) deficiency.

Kursanove (1955) found that the tannin preparation of green leaves of tea brings the hyperactive thyroid gland down to normal, suggesting that green tea tannin or its active constituents may be used in the therapy of toxic goitre. In 1951, green tea infusion was used on a large scale in combating plague in Japan ; it appears that green tea might have functioned by its vitamin P (capillary strengthening) and anti-bacterial activity. Studies by D. N. Das (*Annals of Biochemistry and Experimental Medicine*, **22,** 201, 1962) indicate strong anti-bacterial activity of tea (tea infusion) particularly green tea, towards certain micro-organisms infecting the gut such as *Staphylococcus aureus* and *Shigella dysenteriae*) ; they suggest a significant role for it in the maintenance of intestinal hygiene and prevention of infection by suppurative organisms.

P.K

Organic silicates for diverse uses

Organic silicates or esters of silicic acid, though they were first synthesised in 1846 by J. J. Ebelman in Germany, shot into prominence only a century later. Since then, their potential has been exploited in a wide range of industries but their real worth has not been fully reflected due to the emergence of the more sophisticated silicones on the industrial scene.

Among these silicates, the orthosilicates, dimer silicates and polysilicates of the general formula $Si(OR)_4$, $(OR)_3Si\text{-}O\text{-}Si(OR)_3$, or $(\text{-}\overset{|}{\underset{|}{Si}}\text{-}O\text{-}\overset{|}{\underset{|}{Si}}\text{-}OR)_n$ respectively, where R is an alkyl or aryl group, can be conveniently prepared by the reaction of silicon tetrachloride ($SiCl_4$) with a dry or aqueous alcohol or phenol. Silicon tetrachloride is obtained by the reaction of metallurgical grade silicon, ferrosilicon or silicon carbide with chlorine, the reaction, once initiated at 400°C, being autothermic. Chlorination of paddy husk which contains up to 20 per cent silica in fine form is currently gaining attention as a cheaper method of producing purer silicon tetrachloride.

The ease of hydrolysis of the lower alkyl silicates, particularly ethyl silicate, which results in a bonding type of silica, has enabled the use of this material in chemical, metallurgical, ceramic, plastic, textile and electronics industries. In the United States alone, nearly 20 million kg of ethyl silicate is produced annually as n-ethyl silicate $Si(OC_2H_5)_4$ or ethylsilicate '40', $Si_5O_4(OC_2H_5)_{12}$; these materials are mainly used in the foundry industry for investment casting and as a medium for zinc-rich paints. Intricate castings, from alloys difficult to machine or forge, with an accuracy of 1·25 mm or better by the 'lost wax' process have been produced using ethyl silicate. Stainless steel, copper, and nickel alloys and iron-chromium alloys have also been cast by this method for the manufacture of surgical equipment, turbine blades, etc.

Ethyl silicate-based zinc-rich paints have proved versatile in coastal and inland environments, chemical processing, pulp and paper, water supply and sewage lines and petroleum and other industries. As inorganic zinc is unaffected by radiation, these coatings have been used to protect steel in the containment shells of most of the new atomic power plants with a design life of 40 years; the inorganic zinc is expected to protect the containment vessel throughout this period.

Other minor applications of ethyl silicate are in heat-resistant paints, as supporting media for flammable liquids in the production of solid fuels, as a source of fine silica and a bonding agent in the manufacture and application of phosphors, in the preparation of dental cement, and as a cross-linker and intermediate for silicones. Another important lower alkyl silicate is butyl silicate used in aircraft sealants.

The higher alkyl silicates, while still liable to hydrolysis, are of great interest as hydraulic fluids, lubricants and coolants because of their wide pressureless liquid phase temperature range of —70°C to 350°C. 2-ethyl-butyl silicate is, for instance, used as a machine gun lubricant and a high temperature hydraulic fluid for military aircraft. Isopropyl, isobutyl silicate, n-octyl silicate and aryl silicates of the type tetracresol silicate are used as heat transfer media in chemical process industries. The organic silicates are also used as base stock for compounded lubricants and lubricating greases for high- and low-temperature performance in weapons, refrigerators, compressors, etc.

In India, the use of organic silicates has been limited to foundry applications. Ethyl silicate for this purpose was so far imported and recently a plant, with a capacity of two tons/day of ethyl silicate '40', has been set up. At the Bhabha Atomic Research Centre, Trombay, development work on organic silicates has been in progress for the last three to four years. The know-how for the preparation of ethyl silicate and ethyl polysilicate was developed initially and these materials have been successfully used within the establishment for metal castings, high temperature extrusion of metals and passivation of electronic devices. The material is also being supplied regularly for making moulds for dentures.

The work has now been extended to develop ethyl silicate-based radiation resistant paints and to improve the quality of cheap woods by impregnation with mixed ethyl silicate and organic monomers followed by radiation polymerisation. A higher alkyl silicate-based fluid (OES-54) has also been developed as a fluid for vapour diffusion pumps to substitute the silicone fluids being now imported. Among other higher temperature applications being contemplated are the use of some of the higher alk silicates and polysilicates for hig temperature transformer applicatio and as heat transfer media.

N. S. K. PRASA

[Dr. Prasad is with the Chemical Engineeri Group, Bhabha Atomic Research Cent Trombay.]

Smokeless domestic oven

A NEW, smokeless, regenerativ high efficiency domestic ove developed by the Centr Mechanical Engineering Researc Institute, Durgapur, has been adjud ed the best design in an all-Indi competition organised recently by Co India Limited.

The oven consists of a cylindrica core chamber with an annular chan ber around it. The annular chamber closed at the bottom and has removable top cover. During norma cooking, coal fines are kept and burn in the annular chamber. Besides pro viding insulation, the annular cham ber acts as a regenerator as it utilise a portion of the heat (which is nor mally lost in a conventional domesti oven) to produce coke for subsequen burning in the core chamber as smoke less fuel. The volatile gases generate in the annular chamber during th process of coke formation are burn either in a separate gas burner o inside the bed. In either case, th heat utilisation, of about 50 per cent is considerably higher than in th conventional oven (up to 35 pe cent). The burning of the volatil gases is controlled by a valve.

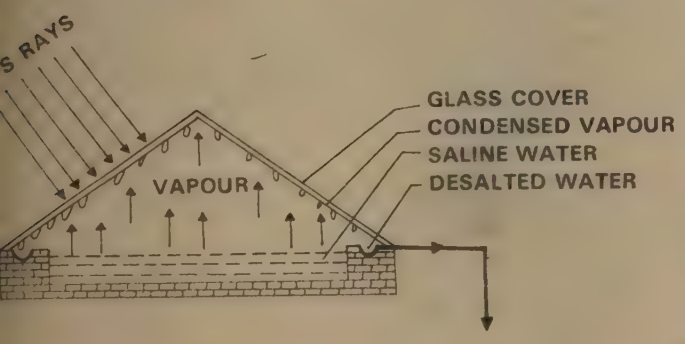
The core chamber is so shaped tha it provides an efficient draft. It hold 1·5 kg of coke, while the annula chamber may contain two kg of coa fines. The oven alone weighs abou five kg. The oven takes about 1 minutes to start up ; the useful fir lasts about 170 minutes, about 2 minutes more than in conventiona ovens. The stove costs about Rs. 3 to manufacture.

K.P.N

Drinking water from salt water

A solar still is a simple, sun-powered means of providing drinking water to isolated communities in regions with abundant sunshine and saline water but no good drinking water nearby. An average annual output of two to three litres per square metre per day has been obtained with a solar still designed at the Central Salt and Marine Chemicals Research Institute (CSMCRI), Bhavnagar (Gujarat).

A solar still duplicates nature's water cycle on a small scale. It consists of a sufficiently air-tight enclosure with a black coloured bottom, containing saline water and covered with



glass or even transparent plastic. The heat of the sun's rays is absorbed by the black bottom. As the water is warmed up, water vapour moves up towards the comparatively cooler cover (which absorbs less heat than the bottom) and condenses there.

Since the still works on solar energy, the output per unit area varies from season to season. The output is also affected by the ambient temperature, wind velocity, water depth, the angle of the glass cover, etc. The smaller solar stills will give higher outputs, as they can be insulated and properly sealed to prevent vapour leakages. In larger solar stills, which are of cement construction in our country, insulation will add to the cost and vapour leakages are comparatively higher.

A concrete pilot still, without insulation, of 15 cm depth, in Bhavnagar, has given an average annual output of 1·9 litres/square metre per day, compared to 2·7 litres for an insulated pilot plant of 2–3 cm depth. CSMCRI have now modified their designs for larger stills and the output now is higher than that obtained in the pilot plant still. Data for output from solar stills in different regions of our country is not available, but in Kashmir, Assam and areas around Cuttack the output is expected to be low.

Solar stills are simple to operate and maintain, having no moving parts. Pumping of saline water into the still can be carried out with wind energy wherever possible, i e, a solar distillation plant will not require any source of artificial energy. Work on installing solar stills in villages is now carried out by the CSMCRI, Bhavnagar.

D. J. MEHTA

[Dr. Mehta is Director, Central Salt and Marine Chemical Research Institute, Bhavnagar, Gujarat.]

Orbital action improves machining

ELECTRICAL Discharge Machining (EDM) is the technique of using high-frequency spark discharges from a soft metal tool, serving as an electrode, to disintegrate electrically conductive materials such as hardened steel or carbide. Originally developed as a method of removing broken taps or drills from holes in castings, it is also called electric-spark machining.

The metal tool is generally connected to the negative of a pulsating DC supply and the workpiece is connected to the positive. With each pulse of the power supply, a spark fires across the small gap between the tool and the workpiece. It is believed that such a spark melts or vaporises a small point of the workpiece that it strikes, and forms a pit-mark or crater, as seen under magnification. The electrode and the workpiece are immersed in a dielectric liquid which flushes away the eroded particles of the workpiece. As the sparks continue to erode the surface, the tool is gradually advanced towards and into the workpiece, eventually forming a cavity or hole that matches the shape of the tool used.

The major attraction of EDM is its ability to produce certain features on parts produced on a limited scale which are difficult or impossible to machine by conventional methods. Further, delicate parts can be machined without damage or distortion, and hardened materials can be machined as easily as soft or annealed metals.

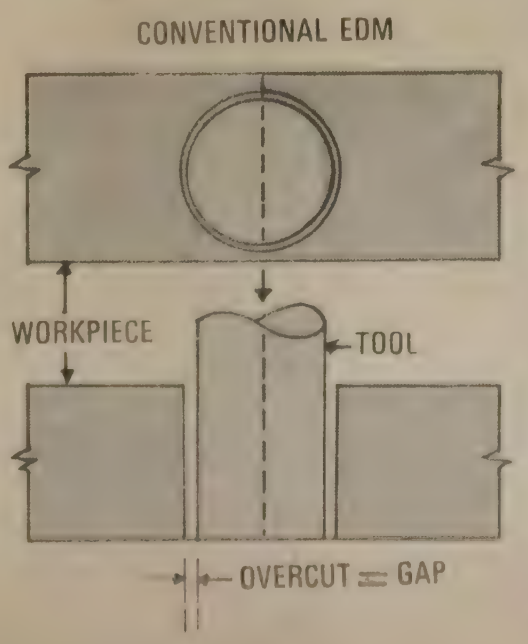
A recent development in the EDM technique now gives it greater versatility in fabrication than in conventional EDM systems. Known as 'Orbital-action EDM', this new concept is simple and efficient. In an orbital action system, the electrode is made smaller than the cavity to be machined. This difference in size is made up by moving the electrode (or the workpiece) in a small circular path, with increasing diameters. In conventional EDM systems, the gap between the electrode (tool) and the workpiece is created only by the 'overcut'. When a very fine surface finish is required, this overcut must be kept very small; increasing the overcut requires a higher spark energy, which, in turn, degrades the finish of the cut surface. A small overcut, on the other hand, would provide a serious disadvantage; the narrow gap hampers the flushing of the metal particles. Also, where the sizes of the cavities are critical, electrodes must be sized accordingly with care.

In an orbital action system, the orbit is generally infinitely adjustable between zero (for static cutting) and 7·5 mm. The gap (one-half orbit + overcut) can thus be as great as 4·25 mm if required. And the larger cut can be achieved without increasing the spark energy, as cutting would actually be done with the electrode very close to the wall, which provides an extremely smooth surface finish.

The other important advantages of orbital action are: (1) the adjustable orbit permits precise control of cavity sizes, (2) the slight electrode wear is easily accommodated by simply increasing the size of the orbit, which considerably increases the useful life of the electrodes, and (3) flushing of the particles is significantly improved because of the wider gap. The continuous motion of the orbiting action actually pumps the fluid around the perimeter of the cut, providing the agitation needed to carry away the debris.

JAY RAJA

[Mr. Raja is an engineer with the Vikram Sarabhai Space Centre, Trivandrum.]



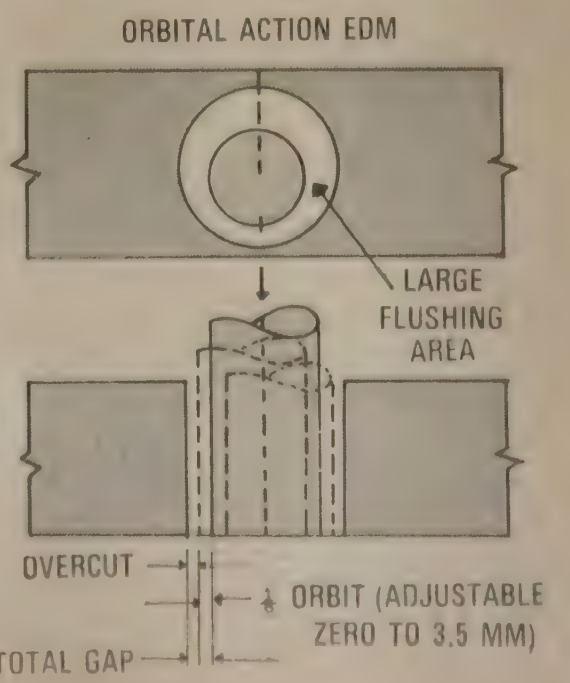


Fig. 1 Infrared binocular using ir converters developed at BARC. While binocular shown in Fig. 2 does not need external light, this type needs external infr radiation

eyes for seeing in the night

C. GHOSH

We dread darkness. Darkness is synonymous with all that is wild and dangerous. It was the discovery of fire that gave man the twin boon of seeing in the dark and security. From fire to other light sources — that has been the story of man's triumph over darkness. But, then, take away the light source and the dread returns.

What would it be like if there were a very simple means to see at night? If it were a simple device like a pair of goggles and if everyone could be provided with one, we might not require street lighting and could probably think in terms of doing away with indoor lighting, too.

Night vision devices do exist. They are not as cheap or easily accessible as to be available to one and all at present, though their capability to see at night is very good. These devices are available in various shapes and sizes and work on different principles. They can help to see everything clearly even on a moonless night without using any other source of light. Fig. 1 shows a binocular with which one can see up to a distance of half a kilometre on a moonless night. How do such wonder night vision devices work?

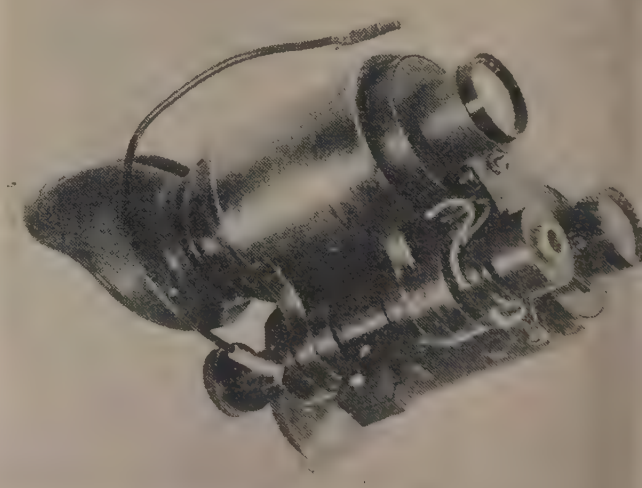
Before we go into the working principle of such night vision devices, let's find out why we cannot see at night. Put the question to any layman and you will get the simplest and most straightforward answer: " It is due to the absence of light ". Not quite accurate an answer, though. Even on moonless nights, we can see objects a few metres away and many animals like owls, cats and tigers find this light sufficient in their hunt for prey. Speaking quantitatively, the illumination level on a moonless dark night is about a million times lower compared to that at broad daylight. Our eye is just not suited for working at this low light level. There's another interesting aspect of illumination. In the day time, the Sun's radiation is the only source of light. It is common knowledge that sunlight comprises radiation corresponding to all colours of which the predominant is green. Our eye is responsive to radiation in a short range of wavelength: it does not respond beyond violet in the shorter wavelength side and beyond red in the longer wavelength side. The colour to which our eye responds best is green, the predominant colour in sunlight. Thus, our eye is evolved for working mainly at day time and we are basically daylight creatures as far as our vision is concerned.

At night, the natural sources of light are the stars and the nightglow. Not only is the illumination level low (as mentioned above), but the spectral distribution, or crudely speaking, the colours comprising this light are different. This light is rich in the near infrared radiation and contains very little of the visible range of the human eye. If the human eye had sensitivity a little farther in the longer wavelength region, we would possibly have had night vision capability comparable to many nocturnal animals'.

From the ab discussion, the two aspects of ni vision become obvious. First, it desirable that the device to aid ni vision should be sensitive to the n infrared radiation to utilise a subst tial portion of the night illuminati Second, the illumination level of night scene should be suitably amp fied (intensified) before it reaches eye. Such devices for intensificat of night image are called intensifie

The principle of working of image intensifying device can be se in Fig. 3. The scene is imaged by lens system on one side of the ima intensifier. Ordinary glass lenses a sufficient. On this side of the devic there is a thin layer of a phot emissive material called photocathod This layer emits electrons dependi on the intensity distribution of lig in the image. For example, if a ma wearing a white shirt and bla trousers is imaged on the phot cathode, the white shirt portion of t image would release a larger numb of photoelectrons than the bla trouser portion and so on. In effe an electron image is emitted from th photocathode exactly correspondin to the light image incident on it. No these electrons are accelerated and a the same time focused on a phospho screen. This screen is similar to tha used in TV sets and cathode ra oscilloscope tubes and generates visible image from the electron image For focusing the electron image fro the photocathode to the phospho screen, special types of focusing elec trodes are used. Since the electron are accelerated to high energies such as 10 to 16 kilovolts, the amount o light obtained at the screen is much more than what was incident on the photocathode end. A brightness in tensification of 50 to 100 times is common in such devices.

Fig. 2 Binocular for seeing in the night It is small enough to go into a pocket



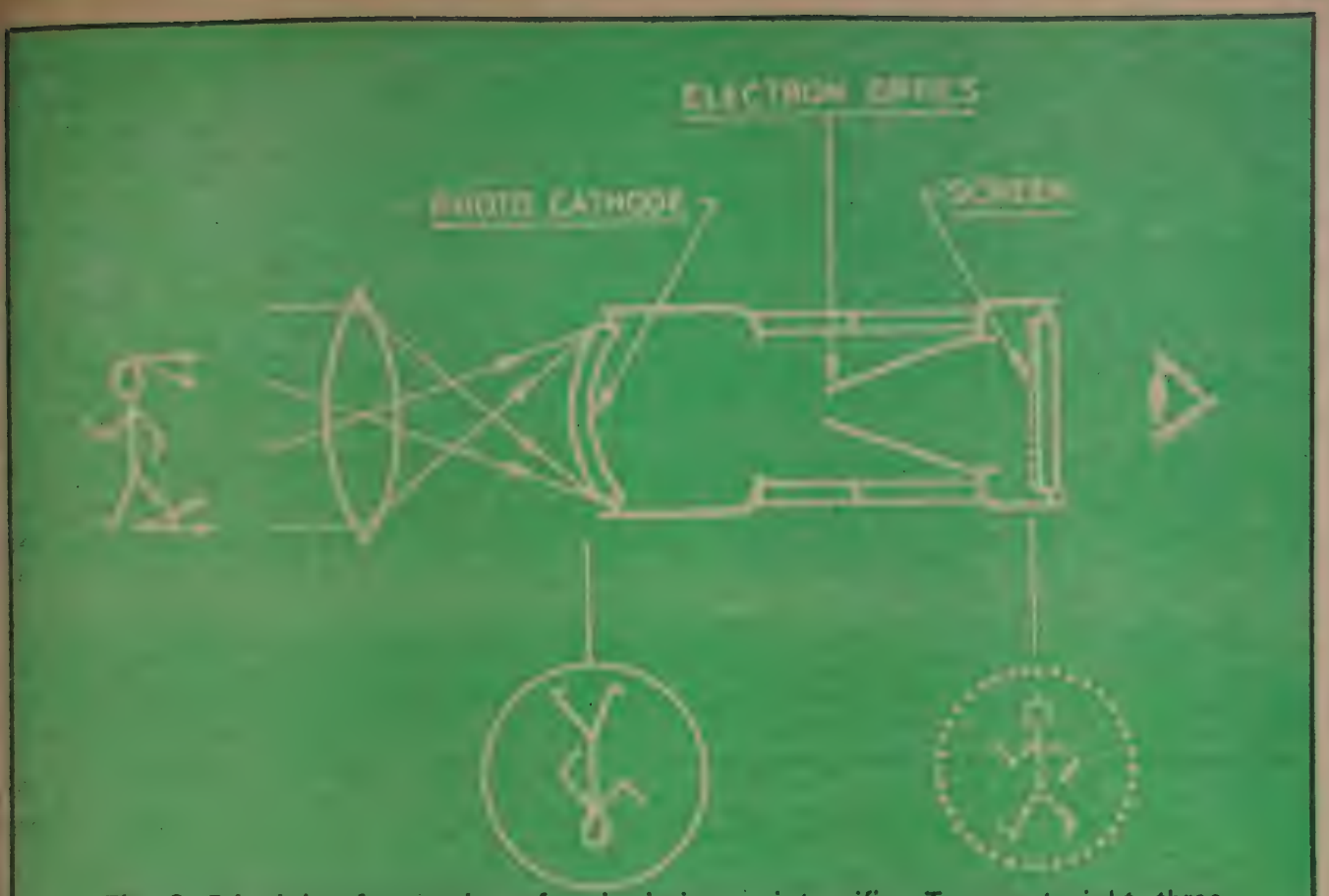


Fig. 3 Principle of operation of a single image intensifier. To see at night, three such tubes have to be cascaded

A single device of this type is not sufficient for the purpose of night vision and usually three such devices are coupled together such that the intensified image of the first device is used as the input of the next and so on. Coupling by lenses would transfer very small amounts of light from one stage to the other and hence fibre optic face plates are used for coupling between successive stages. The fibre optic face plates are fused bundles of very thin glass fibres, the individual fibres acting as light guides. The amount of light intensification is good enough for seeing clearly at night but the device tends to be bulky and is, therefore, a little inconvenient to handle.

In the latest type of image intensifiers (the binoculars shown in Fig. 2), this problem is eliminated and the device is so small that it goes into a pocket. This is why, sometimes it is referred to as ' night vision pocketoscope '. In such a device, a light gain of about a million is achieved in a single small tube. This is due to the addition of an electron multiplying unit, called channel electron multiplier, between the photoemitter (photocathode) and the cathodoluminescent screen (Fig. 4). The purpose of this is to multiply the number of electrons in the electron image by about a million times. The electron image falls on one side of the channel multiplier plate which transmits the amplified electron image to the other side from where it is focused on the screen. In this way, the gain which was obtainable by coupling three stages of tubes is achieved within a single stage pocketoscope.

There is another type of device which uses external infrared illumination to see at night. The infrared illumination is provided by means of a tungsten or xenon-arc lamp from which the visible portion is cut off by using a filter. The night vision device of this kind is called an image converter. The principle of operation of the image converter is similar to that of a single stage image intensifier except that the photocathode in this case is sensitive to the infrared radiation with which the objects are illuminated. Fig. 1 shows an infrared binocular using image converter with which one can see up to a distance of half a kilometre or more (depending on illumination and other parameters) in complete darkness. Such binoculars have already been developed at the Bhabha Atomic Research Centre, Trombay.

The development of the image converters has indeed been a difficult task. The photocathode (see Fig. 3), which in this case was silver-oxygen-cesium type (S–1), has to be prepared in high vacuum of about 10^{-7} mm of mercury. Only ultrapure materials can be used for preparing the photocathode. These materials are to be generated during processing in the vacuum chamber itself. The image converter designed at the Bhabha Atomic Research Centre has seven metal and four glass components, each having very close mechanical tolerance since the dimensions of the high resolution electron lens are very critical. For example, a change of distance of 0·1 mm between the photocathode and the phosphor would drastically reduce the resolution such that the tube would become unacceptable. The components should all be leak-free because the tube should

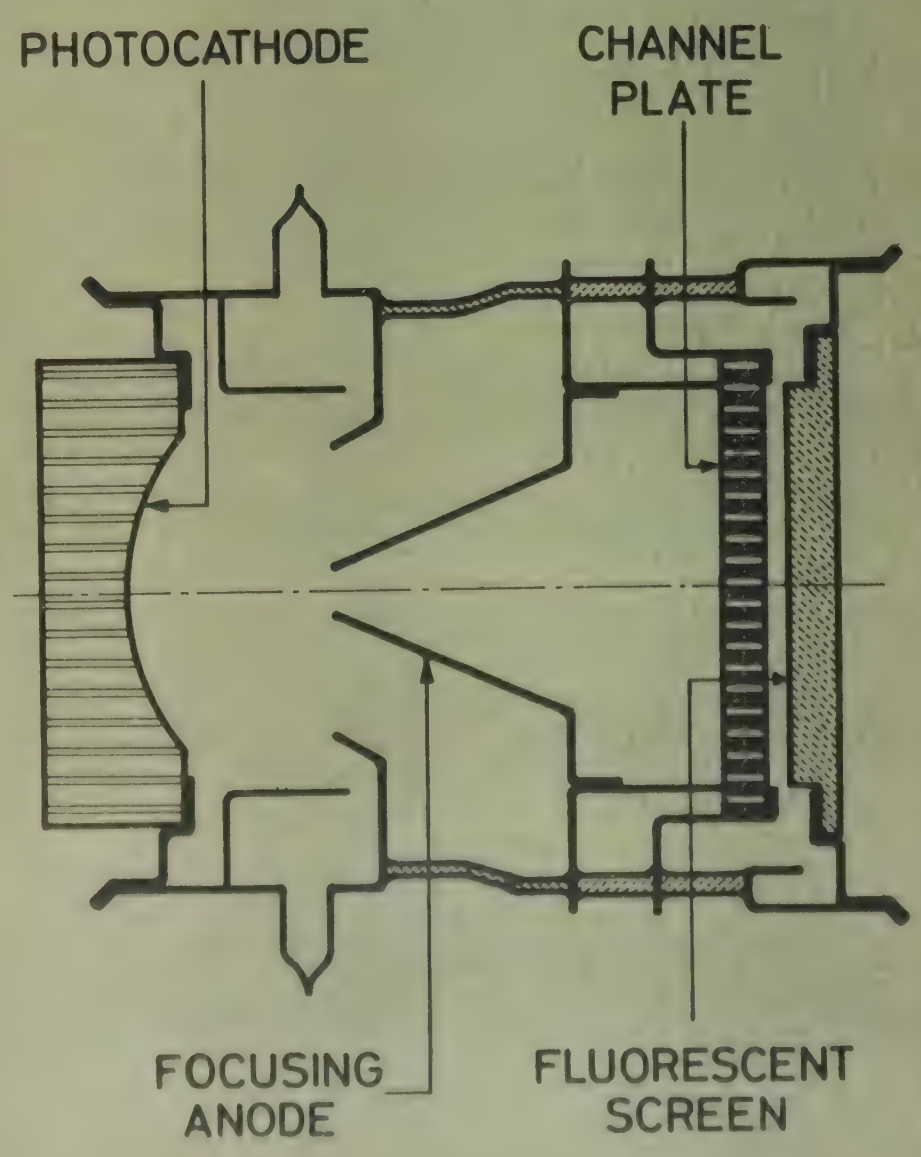


Fig. 4 Principle of operation of a night binocular as shown in Fig. 2

stand high vacuum. Special types of glass amenable to metal sealing and welding techniques had to be developed for fabricating the tubes. The manufacture of these devices is a highly sophisticated technology and only a few countries in the world are capable of doing it.

Then there is another class of devices used for night vision. These do not require any starlight or external infrared illumination. They use the self-emitted infrared radiation from the objects for imaging. We all know that every object ranging from a molten ingot of steel to a block of ice emits infrared radiation. The amount of radiation emitted is dependent on the temperature and

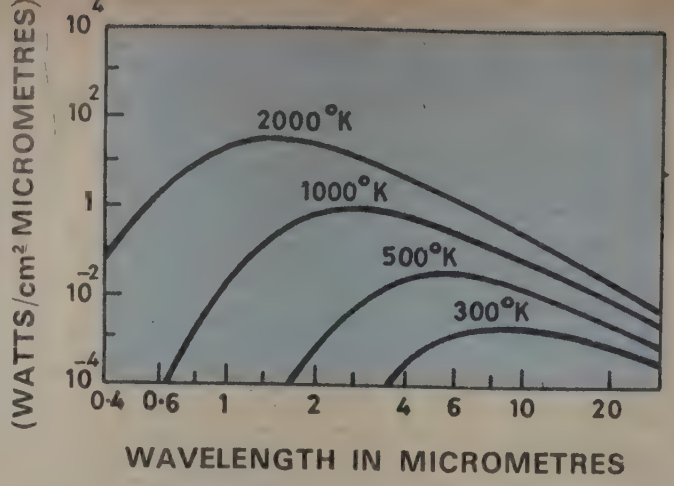


Fig. 5 The spectral distribution of infrared emission from a black body at different temperatures. The perfect black body has an emissivity of unity. Other substances (grey bodies) have less emissivities

objects at much longer wavelengths than those in the range of operation of image converters and intensifiers. For example, the wavelengths for

emissivity differences, the camoufla ing which can deceive human eye detected with them. Fig. 6 shows t photograph (thermograph) of a m hiding in a bush thinking nobo could find him.

Who are the users of all the devices? Obviously, anyone who ca get hold of such devices would like have a look of the 'scenes' whic were so far inaccessible to him. Mi tary applications apart, these are use by police and other law enforceme authorities. An unsuspecting burgl might not be aware that all his mov ments are being watched by a poli patrol from a distance of half a kil metre even though there is comple darkness around him. Study of th behaviour of animals at night witho

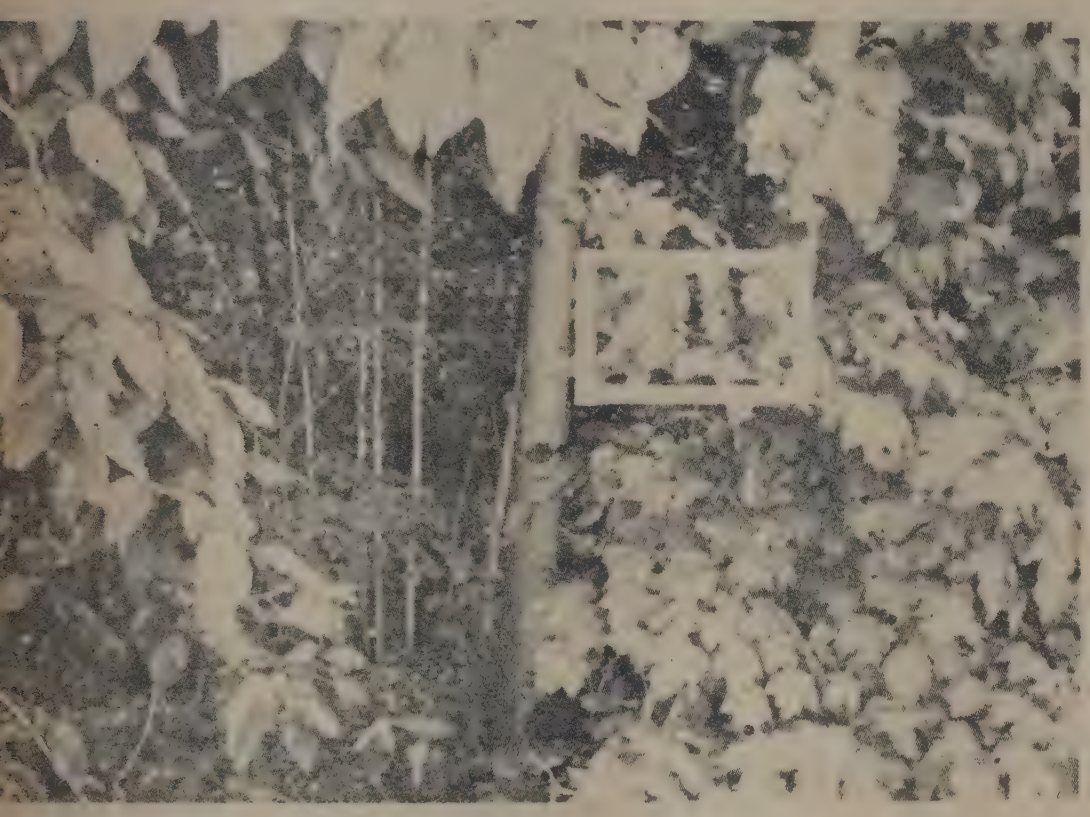


Fig. 6 Comparison of images as seen by the naked eye an the thermal imaging system. The photograph at left was take with an ordinary camera and the one at right is the thermograp of the portion marked by the rectangle

emissivity of the object. Fig. 5 shows the spectral distribution of radiation from a black body at different temperatures. Emissivity is a measure of emission capability of radiation from the object. A black object like graphite or charcoal emits much larger amounts of radiation than does a shiny metal at the same temperature and consequently has higher emissivity. If we consider a night scene, there would be many objects which are at the same or different temperatures and would be emitting different quantities of infrared radiation. Suppose a vehicle is standing against the background of green foliage with its engine running; then the engine would be hotter than the other parts of the vehicle and hence would emit more infrared. The body of the vehicle again would have different emissivity than the foliage background. In effect, this would make a good contrast 'scene' in the infrared. The device which is meant to image this scene should be able to detect the very small amount of radiation emitted from the different

operation of image converters and intensifiers are near one micron (millionth of a metre) while the range of these detectors is 8 to 14 microns. (Devices based on photoemission do not work in this range of wavelengths.) Therefore, mostly photoconductive (materials whose resistivity changes with light) detectors are used with mechanical scanning of the scene like some earlier version of television camera tubes (image dissectors), and the image can be seen on a television screen. More recently, some other types of detectors based on the principle of pyroelectricity (generation of potential difference on heating the material) have been developed. The infrared radiation from the scene falls on a pyroelectric material. It causes heating of the material and the potential developed is 'read' by a scanning electron beam as in vidicon type of television camera tubes (see SCIENCE TODAY, October 1972).

Such devices make all conventional sorts of camouflaging useless. Because they 'see' the temperature and

disturbing them is another interesting use. Image intensifiers are extensively used to intensify the image of faint stars and other astronomical events. They are used in many other scientific applications wherever amplification of light levels and detection of faint images are needed.

Dr. C. Ghosh (29) did his MSc from Burdwan University and took his PhD from Bombay University in 1976. He joined the Bhabha Atomic Research Centre in 1969 where he is now Scientific Officer in the Optoelectronics Division. He is currently working on the development of several types of photoelectronic imaging devices as well as semiconductor materials which can give better photoemission.

Recommends reading: **1.** Sommer, A. H. 1968 *Photoemissive Materials: Preparation, Properties and Uses.* Wiley, New York. **2.** Biberman, L. M. & Nudelman, S. (Ed). 1971 *Photoelectronic Imaging Devices, vols. 1 & 2.* Plenum, New York. **3.** Schagen, P. 1975 *J. Phys. E., 8,* 153. **4.** Morgan, B. L. & Airey, R. W. (Ed). 1976 *Advances in Electronics and Electron Physics, vol. 40A,* Academic Press, London.

Learn while you play—14

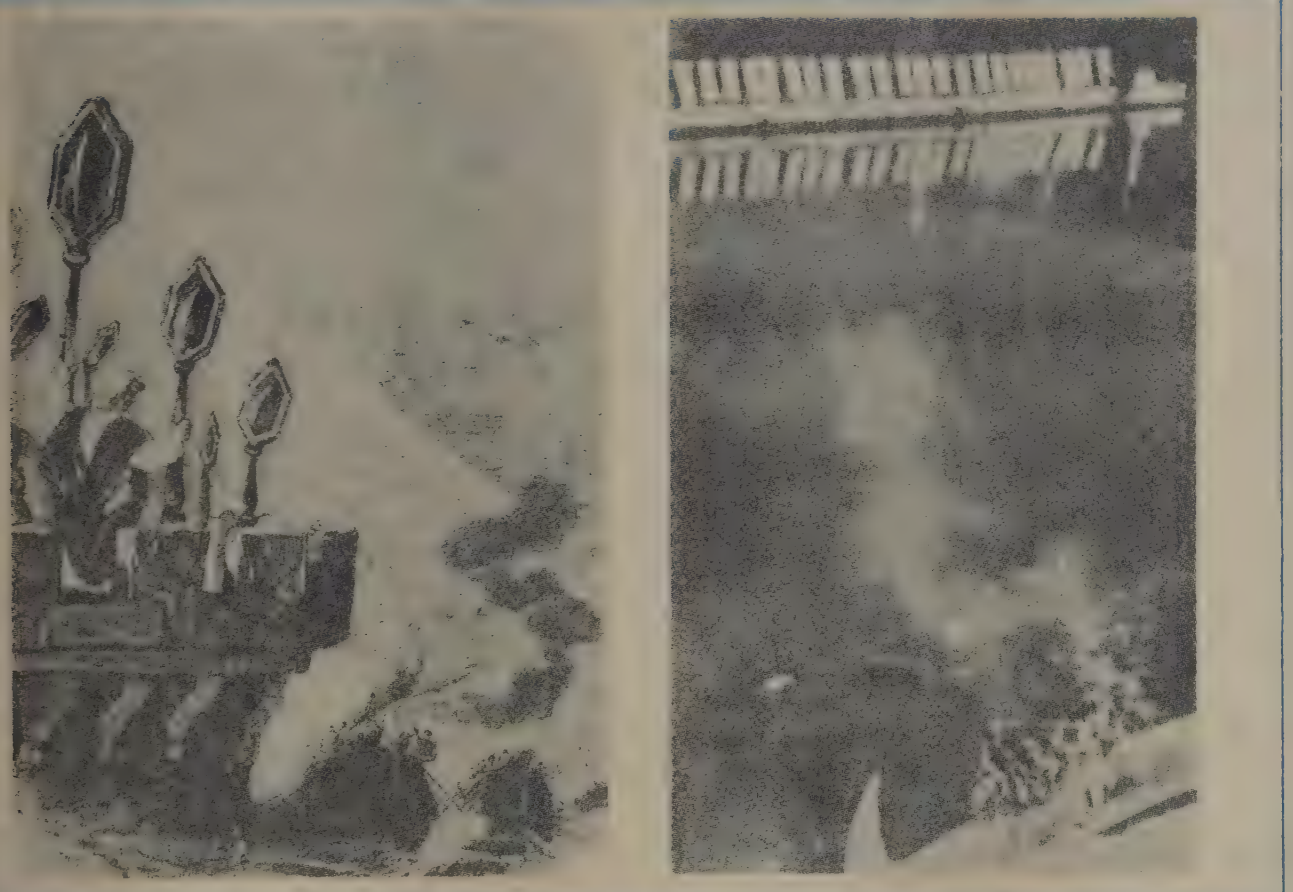


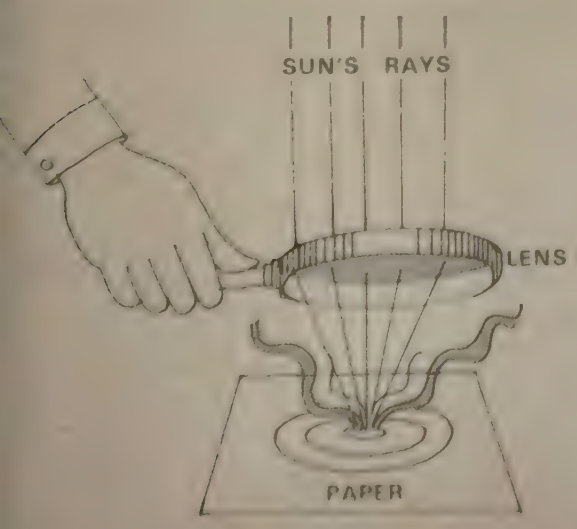
Fig. 1 (Left) An old engraving showing the artist's concept of how Archimedes could have accomplished the feat of burning the Roman fleet. (Right) Actual burning of a rowboat in the Athens harbour in Ioannis Sakkas's 1973 experiment

B. D. KELKAR
A. V. DESHINGKAR

LEGEND says, Archimedes, the great Greek scientist who is said to have discovered the buoyancy of water, once saved his home port from the attacking Roman fleet by devising a 'burning mirror' with which he focused the Sun's rays on to the Roman ships and set them on fire. For centuries, historians have dismissed the story of Archimedes's burning mirror as a myth.

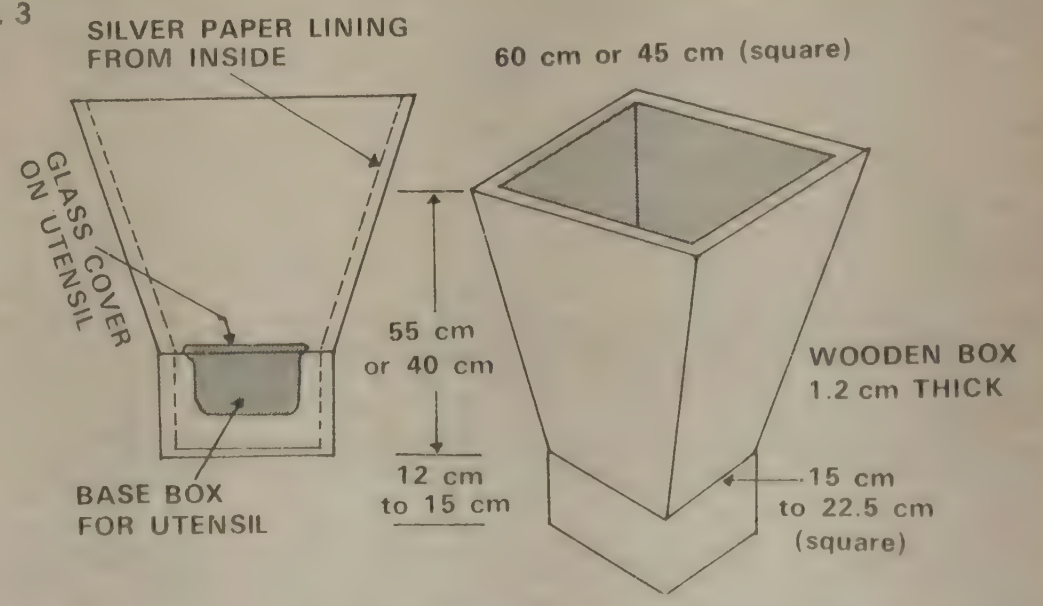
In 1973, Ioannis Sakkas, a Greek expert on solar energy, proved Archimedes could indeed have done just what the legend says. With the aid of the Greek Navy, Sakkas arranged for 70 mirror-bearing sailors to focus the reflected sunlight on a rowboat about 50 metres offshore: the boat caught fire within five seconds!

Fig. 2



How often you must have tried to focus the Sun's rays through a magnifying glass to set a piece of paper or some twigs aflame! Like Archimedes, you too have used the Sun's energy to obtain heat and fire. All over the world, living under the shadow of a growing energy crisis, scientists are trying to do just that — in a much larger scale, though. These devices range from large solar reflectors to simple household heating devices. You can also try making one. We can call it the 'water lens'. If you spread a plastic cloth across a bicycle wheel rim, tie it by a rope wound around the periphery and after mounting it on a tripod (say, wooden battens), pour water slowly, the plastic sheet will sag and make a water lens. If you place it in bright sunlight, say at 11 am, and keep an utensil with rice and water in it at the focal point of the water lens, you'll have cooked rice after a couple of hours. Don't forget to cover the utensil with a glass lid to prevent loss of heat due to radiation. There are, in fact, varieties of solar cookers. Fig. 3 shows a simple one you can fabricate yourself.

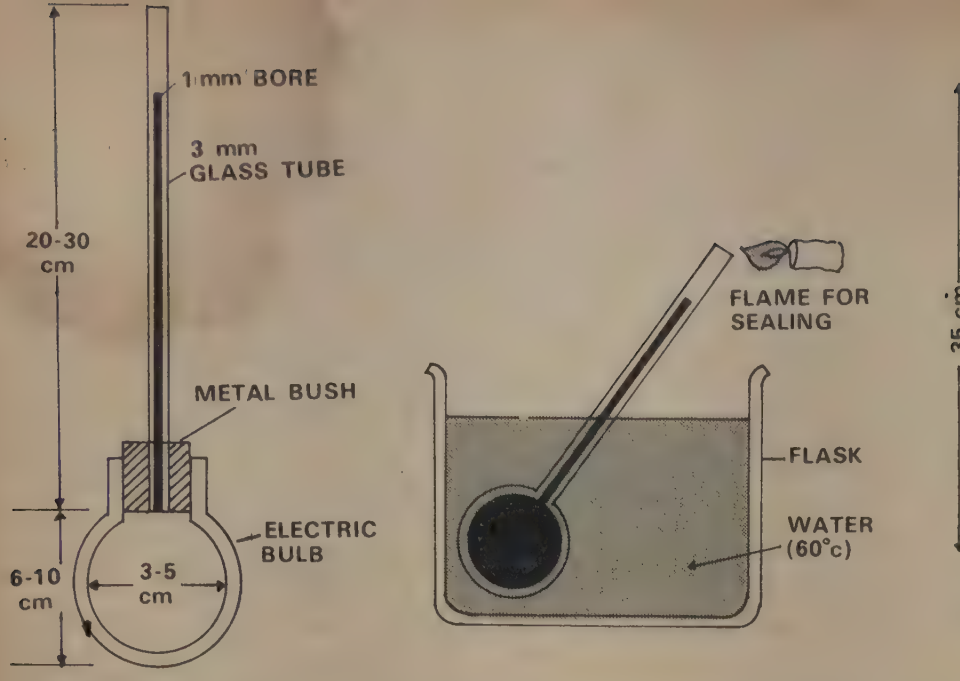
Fig. 3


SILVER PAPER LINING FROM INSIDE
60 cm or 45 cm (square)
GLASS COVER ON UTENSIL
55 cm or 40 cm
WOODEN BOX 1.2 cm THICK
BASE BOX FOR UTENSIL
12 cm to 15 cm
15 cm to 22.5 cm (square)

Temperature and heat

In the winter you shiver with cold; in the summer, the Sun's heat seems to burn your skin. The temperature of a substance is a measure of its hotness or coldness. However, our temperature sensations are not so accurate. Keep your left hand in a bowl of hot water and your right hand in a bowl of ice-cold water and after some time place both hands together into a bowl of lukewarm water — the left hand will feel cold and the right hand will feel rather hot. For accurate measurement of temperature we use thermometers. These are based on the principle that liquids expand when heated and contract when cooled. Mercury and alcohol expand and contract evenly when heated or cooled. Both are used. Mercury is best at ordinary temperatures but coloured alcohol is better for very cold temperatures because it does not easily freeze.

How about making a simple alcohol thermometer? Fig. 4 shows how in different stages. Take a glass tube and blow a bulb at one end or use an electric bulb after removing the filaments. Fill the tube with industrial alcohol by using rubber tubing and a thistle funnel (there mustn't be any bubbles!) and place the thermometer in water at 60°C which is slightly below the boiling point of alcohol, so that the excess alcohol will ooze out. Now seal off the open end with a flame. You can calibrate the thermometer with water at different temperatures and draw the scales. Clamp the thermometer on a cardboard and hang



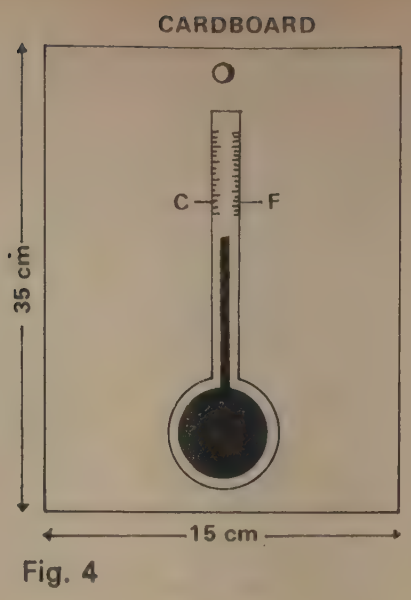


Fig. 4

it from the wall in your study room.

Have you heard of the ancient temple of Alexandria in Egypt where the massive doors would open soon after the altar fire was lit? Fig. 5 shows there was no magic involved as the priests then would have the people believe. The invention was Hero's, the Greek mathematician who lived during the 1st century AD. The fire kindled in the hollow altar caused air to expand down a tube, driving water from one vessel into another. Extra weight in the second vessel caused it to drop and move ropes round the pivots on which the doors were fixed.

In general, when an object is heated — be it solid, liquid or gas — it expands. You can see many examples of expansion due to heat all around you. On hot days, telegraph wires sag. In fact, if they are put up in the summer and stretched tight between their poles, they might break when they contract on cold winter days. Even bridges with long steel girders have one end placed on rollers to allow for expansion (Fig. 6). And

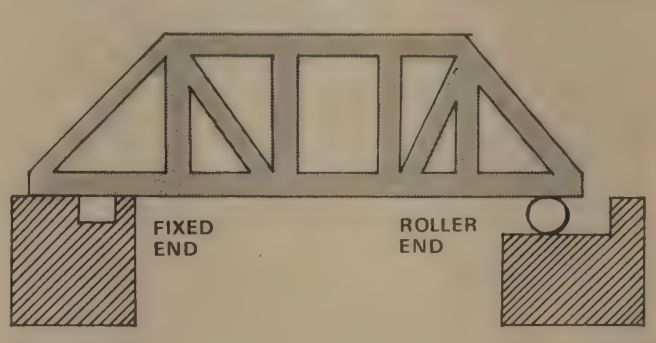
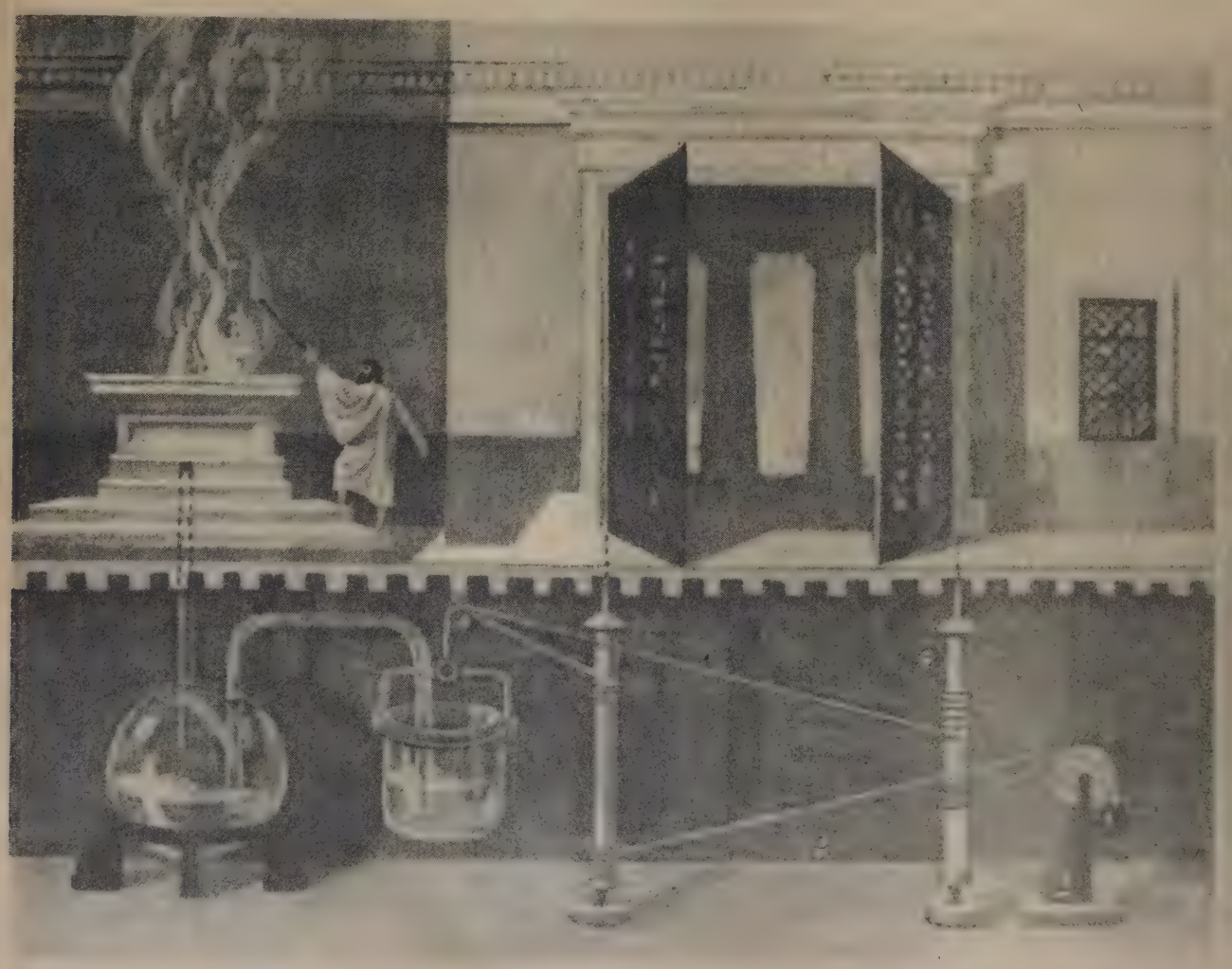


Fig. 6

it is for the same reason that railway tracks have gaps at the joints — to prevent buckling during the summer. Here's an interesting arithmetical problem you can work out for yourself. By what length does the railway track between say, Delhi and Bombay, which is roughly 1,400 km long, extend and contract over the year? Let's assume that the lowest winter temperature is 15°C and the highest summer temperature, 40°C; in other words, a differential of 25°C. H causes steel rails to expand by m than a 1,00,000th of their length every degree C increase. So we calculate the change in the length the track as $1,400 \times 25 \times 10^{-5}$ This works out to roughly metres!

Why does a glass tumbler cra when you pour hot water into it? T reason is, the inside of the tumb expands more rapidly than the outsi and the resulting stress cracks glass. This is why we normally pla metal spoons inside glass tumbl before pouring hot liquids: met unlike glass, is a good conductor heat and hence the glass loses part its heat to the spoon; this offsets t uneven heating of the glass a prevents it from cracking. A silv spoon is ideal in this case.

Fig. 5 Artist's reconstruction of Hero's temple door-opening device



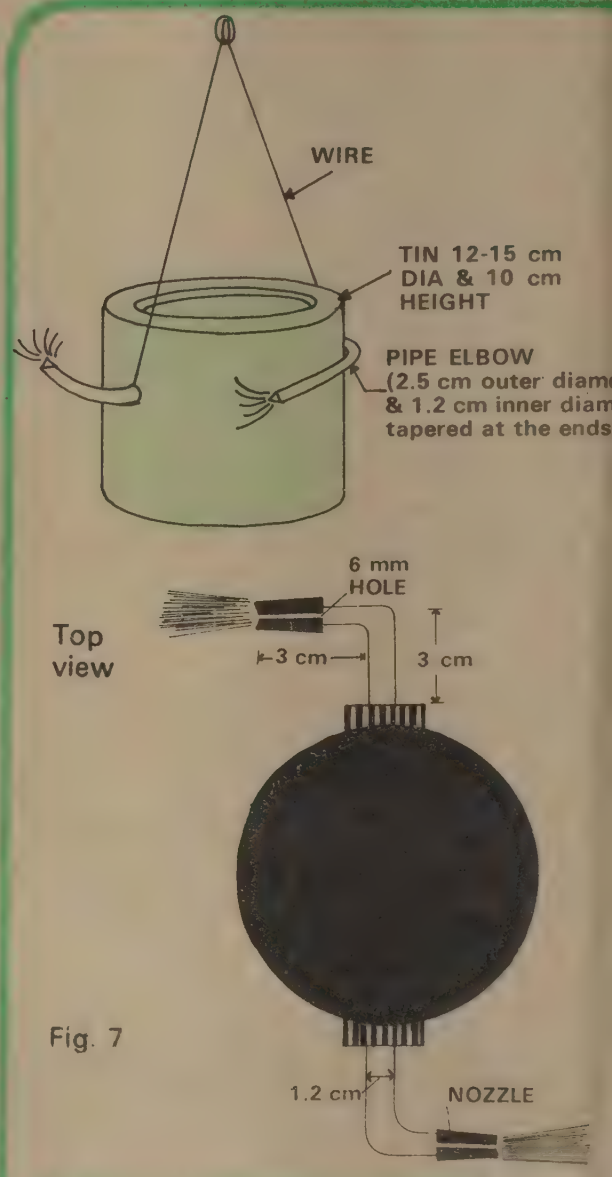

WIRE
TIN 12-15 cm DIA & 10 cm HEIGHT
PIPE ELBOW (2.5 cm outer diam & 1.2 cm inner diam tapered at the ends
Top view
6 mm HOLE
3 cm
3 cm
1.2 cm
NOZZLE

Fig. 7

Hero's steam engine

This toy is a steam turbine prepared on the same lines as that of the inven tion of Hero, the famous Greek scientis of ancient Alexandria.

Take a tin with a tight lid. Pierce two holes on opposite sides of the tin's body, large enough to accommodate one-hole stoppers. Take two elbows o glass or PVC tubing and insert tape hole nozzles in the ends of the pipes Insert the tubes in the stoppers so that the jets point in the opposite directions Fasten a wire string to the stoppers and suspend by a chain. Pour water in the can up to a depth of three centimetres, close the lid tightly and place the tin over a flame. As soon as steam starts coming out, the can will begin to rotate.

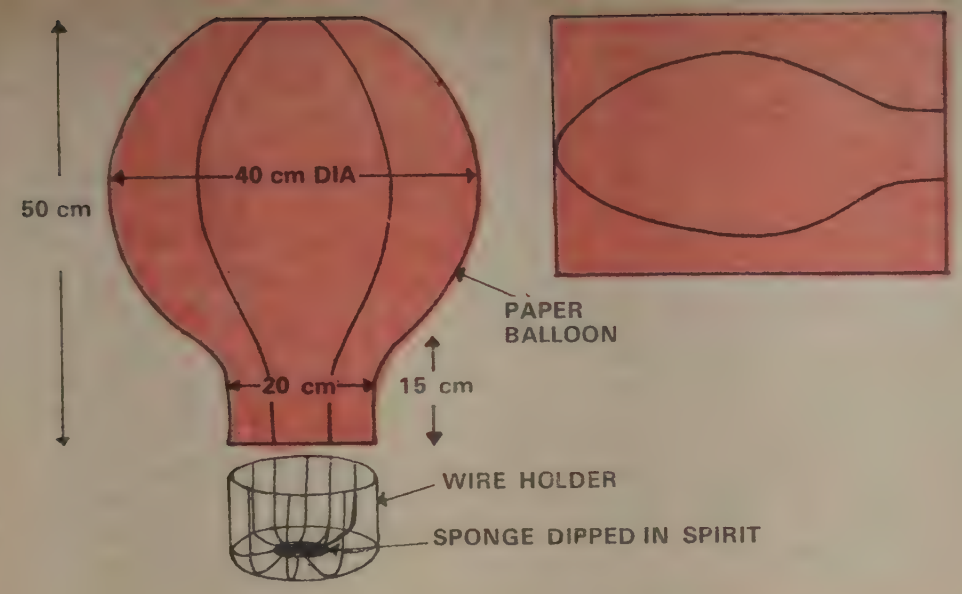


Fig. 8

Like liquids and solids, gases also expand. In fact, gases have a greater expansion than solids or liquids. We can utilise this property to make a simple fire balloon from a large paper bag. Open out the mouth with a ring of iron wire having a stay across the diameter. Fix the ring to the bag with strips of gummed paper. Tie a small piece of sponge or cotton wool to the middle of the stay, dip it in methylated spirit, light the spirit and hold the bag by the ring. You have to be very careful or else the bag will catch fire. As soon as hot air fills the bag, the paper bag balloon will fly — provided, of course, you have made it quite stable. Fig. 8 shows a more dainty model. Place six sheets of tissue paper, one on top of the other, and cut them in the shape of a petal. Now gum the edges to form a balloon. Close the top with a circular disc. Fix a ring to the neck as before. This balloon, if properly made, will rise to great heights and can be flown from a string like a kite.

Motor car engines are also driven by the expansion of gases. The gas expands when the fuel explodes and pushes the piston down in a cylinder. The piston rotates the crankshaft through a connecting rod. The crankshaft, through the clutch, the gearbox and the differential, moves the wheels. In Figs. 7, 11 and 13 are three more toys that you can make and have hours of fun with.

Fig. 9

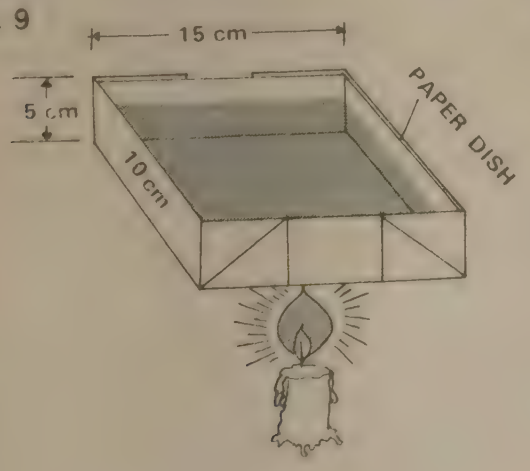
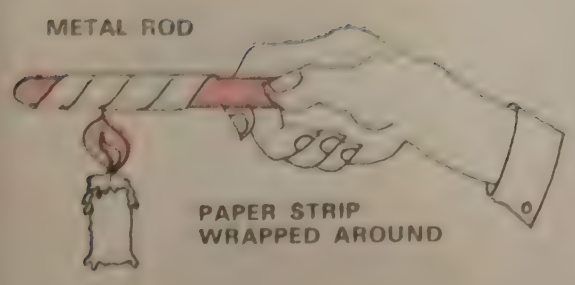


Fig. 10



Paper steam ship

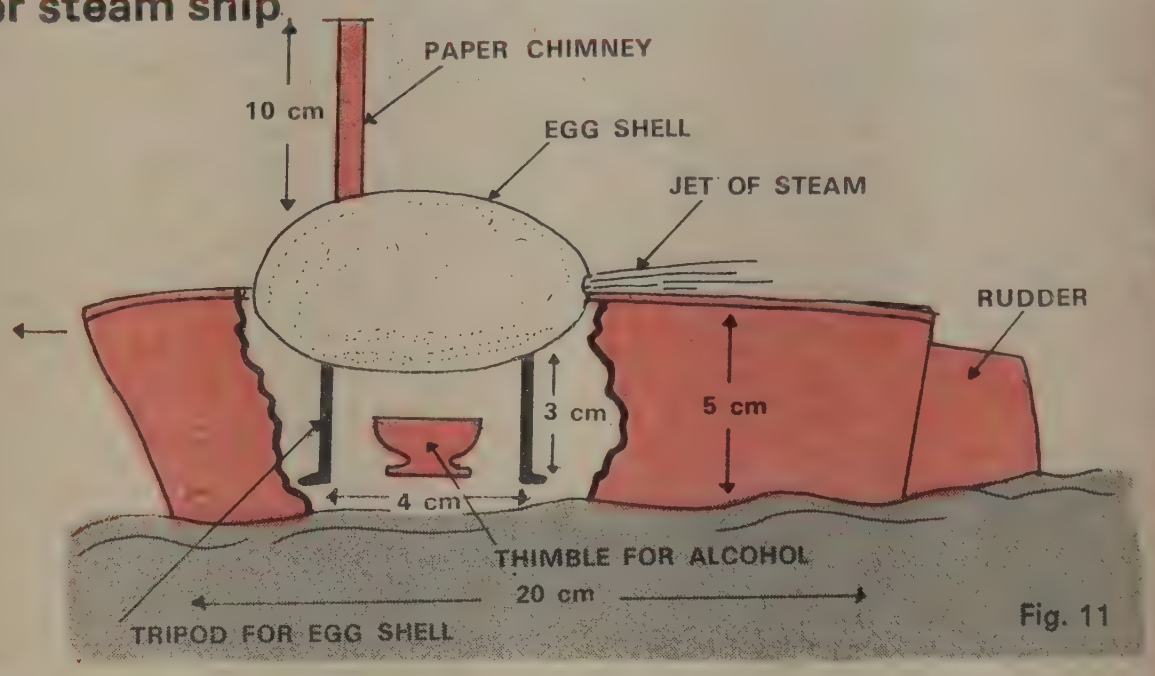


Fig. 11

Prepare a paper ship from card paper. You need a steam boiler. Use an empty eggshell which can be filled with water. You can make a very small hole on its top to place a rolled-up paper chimney. The eggshell can be heated by igniting a piece of cotton wool soaked in alcohol and placed in a thimble below the eggshell. As the water in the eggshell gets heated, it will send a burst of steam through the nozzle hole and the ship will move forward as a result of the 'reaction' in the opposite direction.

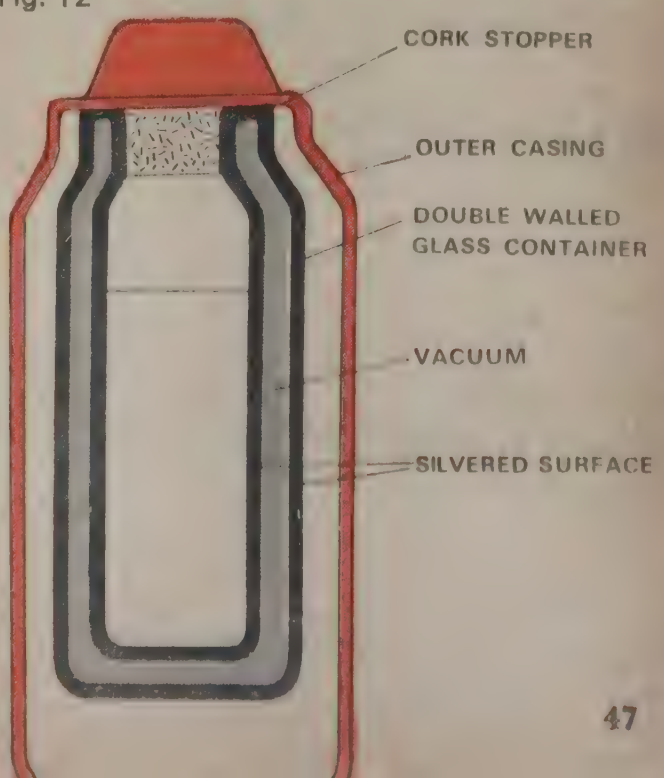
Conduction and insulation

You must have wondered while making the toy steam boat why the eggshell filled with water did not burn! Because of the water! Water has great capacity to absorb heat; it absorbed the extra heat of the eggshell and the eggshell did not burn even though licked by the flame. Your friends will not believe you if you tell them you can *boil water in a paper dish!* How about showing them how? See Fig. 9 and prepare a paper container – take hard paper so that the dish does not collapse when filled with water. Hold it over a flame and the water will boil.

Fig. 10 shows another simple experiment. Take a steel rod — or better a copper rod — and wind tightly a narrow strip of paper around it. Hold it over a flame. The flame will lick the paper, may even smoke it, but will not produce flames — not until the rod becomes very very hot. You must have guessed the reason — the metal rod is a good conductor and takes the heat away from the heated paper strip. A glass rod or a wooden bar will not do as these are bad conductors of heat. Bad conductors are called insulators. Most liquids are bad conductors. So are gases. Woollen clothing stops heat from being lost from the body because the air trapped between the strands of wool is a bad conductor.

A vacuum does not conduct at all. This is because there are no molecules to carry the heat away. This principle is made use of in our vacuum flasks to keep things hot or cold. A glass bottle inside the flask has double walls from which the air has been removed. The walls are also silvered to stop heat loss due to radiation (Fig. 12).

Fig. 12

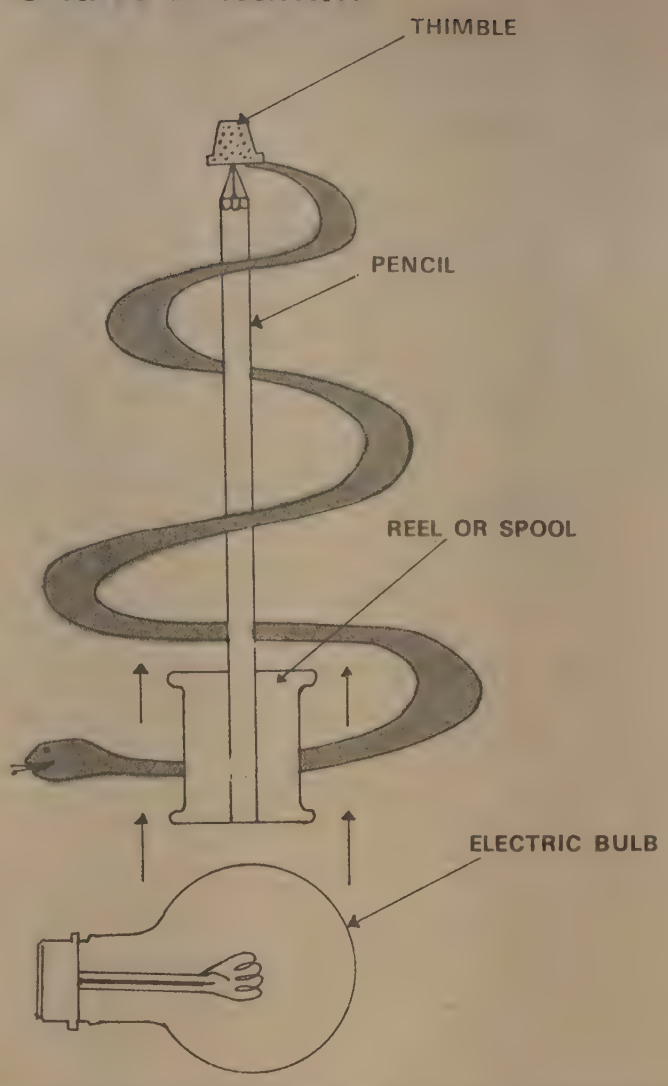


When water is heated in a saucepan, ripples can be seen on the surface. This is due to convection of heat — a phenomenon seen only with liquids or gases where heat transfer takes place by movement of the material itself. Convection occurs because gases and liquids expand when they are heated. This expansion makes them less dense than the surrounding material. The lesser density makes them rise and their place is taken by the cooler, more dense fluid from above. These convection currents can be quite strong. Place a paper windmill above an electric bulb and watch it spin around. Fig. 14 shows a fascinating toy that works by the convection currents of hot air rising from a candle or an electric bulb.

Here is another simple toy that may look really baffling as it twirls around. Take some thin cigarette paper and cut out a rectangular piece from it. Fold it along the middle and then straighten it again — the fold will tell you the position of the centre of gravity. Now stick a needle upright into the table and place the paper piece on it somewhere along the fold so that it remains well balanced (Fig. 15). Bring your hand close to the paper — gently, or else the paper will be blown away by the air current generated by the hand's movement. The paper piece will start rotating — first slowly, then faster. Take your hand away and the rotation will stop. Bring your hand close again and the rotation will start again. You will notice that the piece of paper alwa rotates in the direction from the wri towards the fingertips. This is becau the fingertips are always colder tha the palm of the hand; consequentl the palm gives rise to a strong ascending air current than from th fingertips.

Let's end this piece with a rathe intriguing toy. It was actually devise by Feynman and appears in th *Feynman Lectures in Physics, Vol.* (1963). Did you know rubber *con tracts* when heated? Fig. 16 shows toy wheel mounted on a heavy woode base and placed next to an electri bulb. The spokes of the wheel ar rubber bands. After you switch th bulb on, the rubber bands will ge heated and will shrink. The wheel wi begin to turn. Do you know why The wheel turns because the shrinkag in the rubber bands displaces th wheel's centre of gravity.

Snake windmill



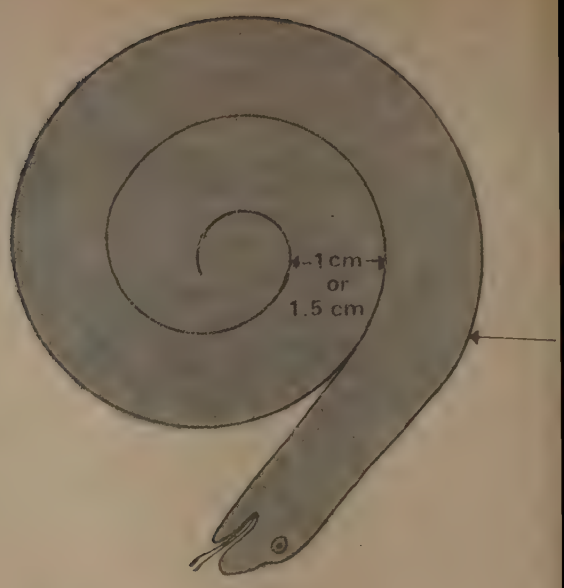
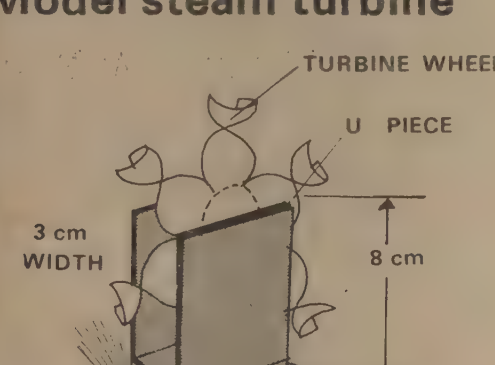


Fig. 14

Draw a spiral on a circle of card pa as shown in the figure. Cut along spiral and pull it out a little into a c Attach a nail or a pin to a hard cap su as a thimble or a small bottle-t Stick a pencil or a thin wooden st into a thread spool and make it sta upright. Balance the tail of the spiral the sharp point of the nail attached the pencil-top. Place the windmill an electric bulb and it will begin spin around as the rising air curre flow along the spirals.

Model steam turbine



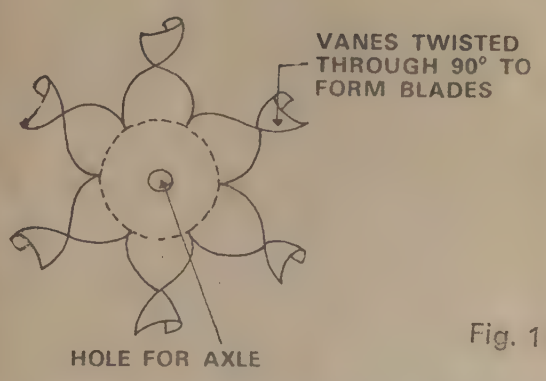


Fig. 13

This turbine model is really very simple to make. You will need a tin can with a lid and a wheel with blades. The wheel can be made by cutting radial slots from a circular piece of tin and twisting the ends. Use a nail as an axle and the axle support is made from a tin piece bent into U-shape and soldered to the can-top.

Make a hole on the lid for steam to issue out in a jet form. You will have to locate the hole properly so that the jet hits the blades sufficiently strongly to make the turbine rotate.

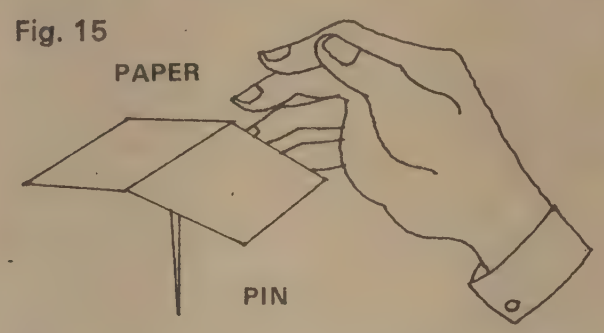
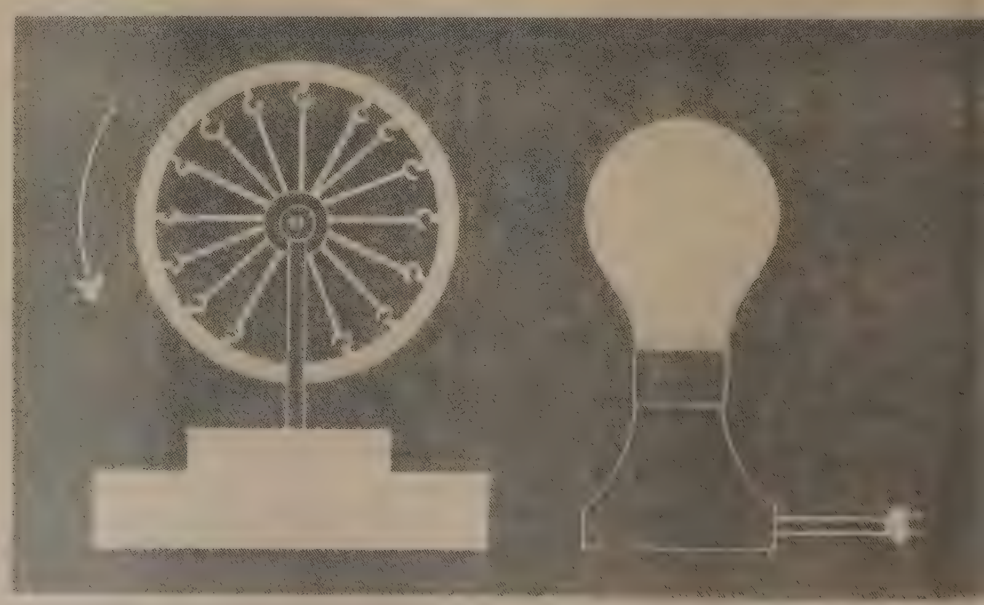


Fig. 15

Fig. 16



The cosmological question

THE STRUCTURE OF THE UNIVERSE by Jayant Narlikar, Oxford University Press, London, 1977, Rs. 31·00, £ 1·95, 264 pp.

FROM the beginning of civilisation, man has been curious about the nature of the universe and his own place in it. Mythologies of all lands are replete with accounts of the origin of the cosmos derived from their limited daily observations and according to their respective genius. The theme of a sky-god and mother-earth recurs in all continents at chronologically diverse epochs.

While these primitive stories were being incorporated in the religious texts, the more curious and daring among men were trying to build logical models of the universe. It is interesting to note that there are three distinct speculative pictures presented by the early civilisations which have their counterparts in the modern cosmological theories. The Christian and Islamic theologies conceive of a beginning and an end of the universe. The Chinese, on the other hand, believe that the universe is everlasting, while the Indians prefer a cyclically changing universe with repeated creation and destruction. The three view-points correspond, respectively, to 'The Big Bang', 'The Steady State' and 'The Pulsating Universe' theories of modern cosmology. Prof. Narlikar has described, in this volume, the observational background, the conclusions and the implications of these and other modern theories of the origin and structure of the astronomical universe.

An astronomer's task is more difficult than that of research workers in other branches of science ; the objects of his study, the heavenly bodies, are situated far away and outside the reach of the normal experimental process. He has to rely only on his interpretation of the various properties of the electromagnetic radiations received from them. Naturally, the procedures used by astronomers for deciphering the coded messages from those remote denizens of space are both laborious and involved, while the results are staggering. Prof. Narlikar has done a remarkable job in describing the intricacies of the subject in a most lucid manner. He has been particularly successful in bringing out the basic unity of the local (terrestrial) and global (universal) approaches to the scientific enquiry of physicists and astronomers, respectively.

Of the eight chapters, the first and the last are in the nature of an introduction and an epilogue. The remainder can be divided into two parts. The first part, consisting of Chapters 2 and 3, is devoted to a description of the various constituents of the universe — the stars, the interstellar space, the Milky Way and the external galaxies which form the building blocks of the universe. Stellar evolution, thermonuclear synthesis of elements and high-energy phenomena are discussed and the significance of bizarre objects such as the white dwarfs, neutron stars (pulsars), black holes, radio galaxies, quasars and the recently discovered X-ray and γ-ray sources in the scheme are pointed out at appropriate places. The second part, consisting of Chapters 4 to 7, forms the main thesis of the book, which gives an exposition of the nature of the universe as a whole. After discussing the various cosmological theories based on Hubble's discovery of the recession of galaxies, the author examines in depth the Newtonian and the General Relativistic concepts of gravitation, the relationship and interdependence of the thermodynamic, the electromagnetic and the cosmological arrows of time, and, finally, the observational tests of the proposed cosmological theories.

In an impartial assessment of the available data, Prof. Narlikar concludes that, due to the prevalent uncertainties of observations, most of the usual tests, such as the redshift-magnitude relation, source counts and variation of angular diameter with distance are still unable to distinguish between the many cosmological models of the evolving Friedmann type and the model based on the Steady State Theory. The only observation which rules out the Steady State Theory is that of the 3-degree background radiation. On the other hand, the electromagnetic and thermodynamic arrows of time can be reconciled with the cosmological arrow of time through the Wheeler-Feynman theory only if the universe is in a steady state. Thus, according to the author, the commonly accepted Big Bang Theory is neither proved, nor is the Steady State Theory disproved.

Many astronomers may not agree with these conclusions. My personal opinion is that, whatever the final fate of the Steady State Theory, it alone has tried to face the problem of creation of matter. And some of its ideas, particularly the concept of the C-field in an altered form, might be found useful in treating the problem of the sudden creation of matter at the original singularity of the Big Bang models. New ideas introduced in the field of astronomy have seldom disappeared completely. Helmholtz-Kelvin gravitational contraction as a source of stellar energy is a good example, which is likely to be simulated in the problem of creation of matter.

Besides the rich content, one additional feature of the book is the introduction of the 'boxes' on more advanced mathematical material, which really make it two books in one. If we leave out the boxed material, we get a popular version which can be understood fairly easily by non-specialists. The boxed material serves as a fillip to those who are not satisfied with the relative insipidity of the popular account. The type and printing of the book is excellent; there are hardly any typographical errors. On the whole, this Opus 77 of the Oxford (paperback) University Series will serve as a landmark in the subject of cosmology for several decades. The book ends appropriately with a pertinent question, whether the unsolved problems of cosmology require new laws of physics, which will surely stimulate further research.

A note about the author may not be out of place here. Prof. Narlikar shot to fame about 14 years ago when he and Prof. Hoyle formulated the C-field theory of the creation of matter. Theirs was an attempt to put the Steady State Theory on a firm mathematical footing on the basis of Mach's principle. His meteoric rise in those days was a matter of envy for many an Indian scientist and they were keen to downgrade his work when the astronomical observation of the 3-degree background radiation later threw some doubts on the Steady State Theory itself. Such hero-worship and idol-breaking attitudes are foreign to the spirit of scientific enquiry, and persons prone to them apparently do not understand the process of the development of scientific ideas. I have known the author for some time now, and I am impressed by his modest but firm attitude, hard and systematic work, attention to detail and concern for the other man's point of view. The present work brings out these qualities abundantly.

K. D. ABHYANKAR

[Prof. Abhyankar is Director of the Centre of Advanced Study in Astronomy, Department of Astronomy, Osmania University, Hyderabad.]

(Contd. on p. 51)

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Textbook on electromagnetism

ELECTROMAGNETISM, ELECTRON THEORY AND SPECIAL THEORY OF RELATIVITY by A. K. Dutta, Macmillans (Low Cost University Edition), 1977, Rs. 20·00 (hard-cover), x + 331 pp.

THOSE who have been taking courses on Electromagnetism both at the B Sc and the post-graduate levels had, all these years, to depend on foreign textbooks. Some Indian textbooks have, no doubt, appeared on the scene recently, but they leave much to be desired. The book under review, written by a retired Palit Professor at Calcutta University, is refreshingly different, and fulfils a long-standing need.

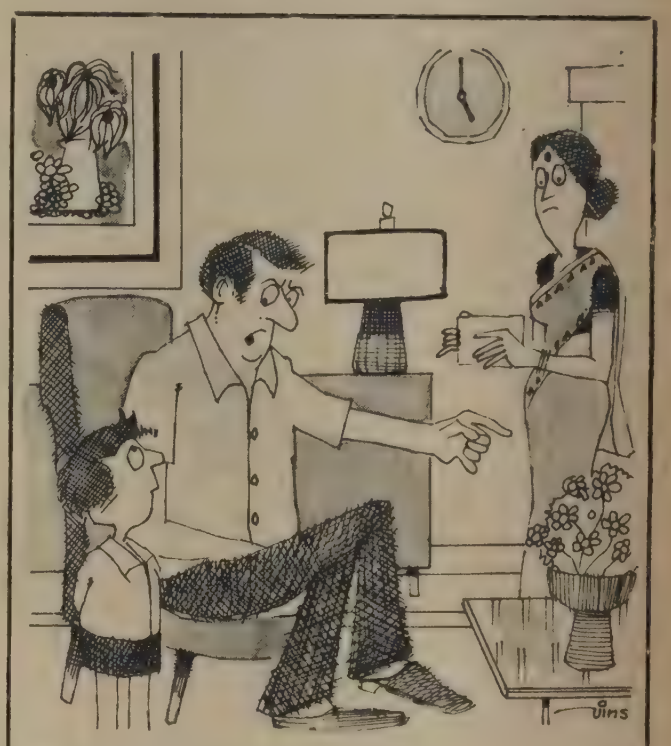
Divided into three parts (Electromagnetism, Electron Theory, and Special Theory of Relativity), the course material chosen can serve as a good one-semester course in electrodynamics in the third year of the new three-year B Sc course. The topics are carefully divided into various chapters which are compact and can serve as suitable units for course planning. The vectors are used throughout and use of tensors is made in relativistic formulation. A brief account of vector and tensor methods is given in an appendix. Einstein summation convention is used in a few places and not used elsewhere (where summation is indicated explicitly.) A few problems, not sufficient in number and not sufficiently challenging, are given at the end of each chapter. A better set of problems would enhance the value of the book. A number of references at the end of each chapter would benefit the discerning student. An excellent reference, that of Heitler's *Quantum Theory of Radiation* (Oxford), which treats many topics in the text, is unfortunately missing among the references given at the end of the book.

A few shortcomings mar the excellent general character of the book. Misprints and omissions abound. These should be carefully looked into and corrected in the second edition. The subject of gauge transformations is treated in a roundabout fashion (the word "gauge" is never used anywhere!). The notation P for the polarisation vector is also used for the so-called curve potential. In the relativistic treatment, the metric (+++−) should have been used throughout rather than mixing it with (++++) with $\tau = ict$. Apart from creating confusion, this mixing serves no useful purpose. The latter metric could have been used throughout, though it is out of fashion in modern literature. Einstein summation convention should have been used throughout avoiding those cumbersome summation signs which are used in most formulae using tensors.

The get-up of the book, including the quality of the paper, binding, printing, etc is of a high standard, and the price is reasonable. I think a soft-cover edition is also available at a cheaper price. With certain reservations expressed above, I have no hesitation in recommending this book to our colleges and universities.

R. V. KAMAT

[Prof. Kamat teaches physics at St. Xavier's College, Bombay.]



"Yes, you are going to do your homework without my calculator, in good old Indian tradition!"

TELL US WHY...

. soap bubbles are round?

The shape of any object is the result of the sum total of forces acting upon the object and within the object. On this basis we can explain why a pendulum hangs straight downwards and why telephone wires sag between poles.

Now a bubble consists of an inside and an outside, separated by a closed shell of soapy film. We do not go into the question of how a bubble is formed. Our concern is to explain why, after it is formed, it takes on a spherical shape. It is of course impossible to list the sum total of forces acting on the soap bubble, since every particle in the universe exerts a force on every other. We can only identify the main forces acting on the bubble. An approximation is thus involved and any conclusions that we draw will be correspondingly approximate.

Having said this, we can identify four main forces as being:

1. Gravity, which acts uniformly on all the matter in the soap film.

2. The molecular forces within the material of the soap film.

3. The pressure of the air inside the bubble.

4. The pressure of the air on the outside of the film.

But since gravity acts with the same strength and in the same direction on all the parts of the bubble, it can only cause an overall downward drift of the bubble. Gravity, therefore, cannot affect the *shape* of the bubble which is decided by how each portion of the bubble is situated in relation to the other portions.

So we move on to the next item — the forces within the film, that is, the forces which the molecules exert upon each other. This is a complicated situation to analyse, for there are many kinds of molecules in soap and innumerable molecules of each kind. But no matter how complicated the molecular make-up of soap, there is a simple fact about these molecules which is relevant here: they attract each other.

It is not difficult to see that any collection of such molecules will tend to contract in size, no matter what its shape. A film of such material will tend to shrink. If it is prevented from doing so, a tension will arise in the material (termed surface tension), much like that within a stretched sheet of rubber which is prevented from contracting. The important conclusion we can extract from the above is very simple: due to its internal molecular forces a soap film has a tendency to decrease in area.

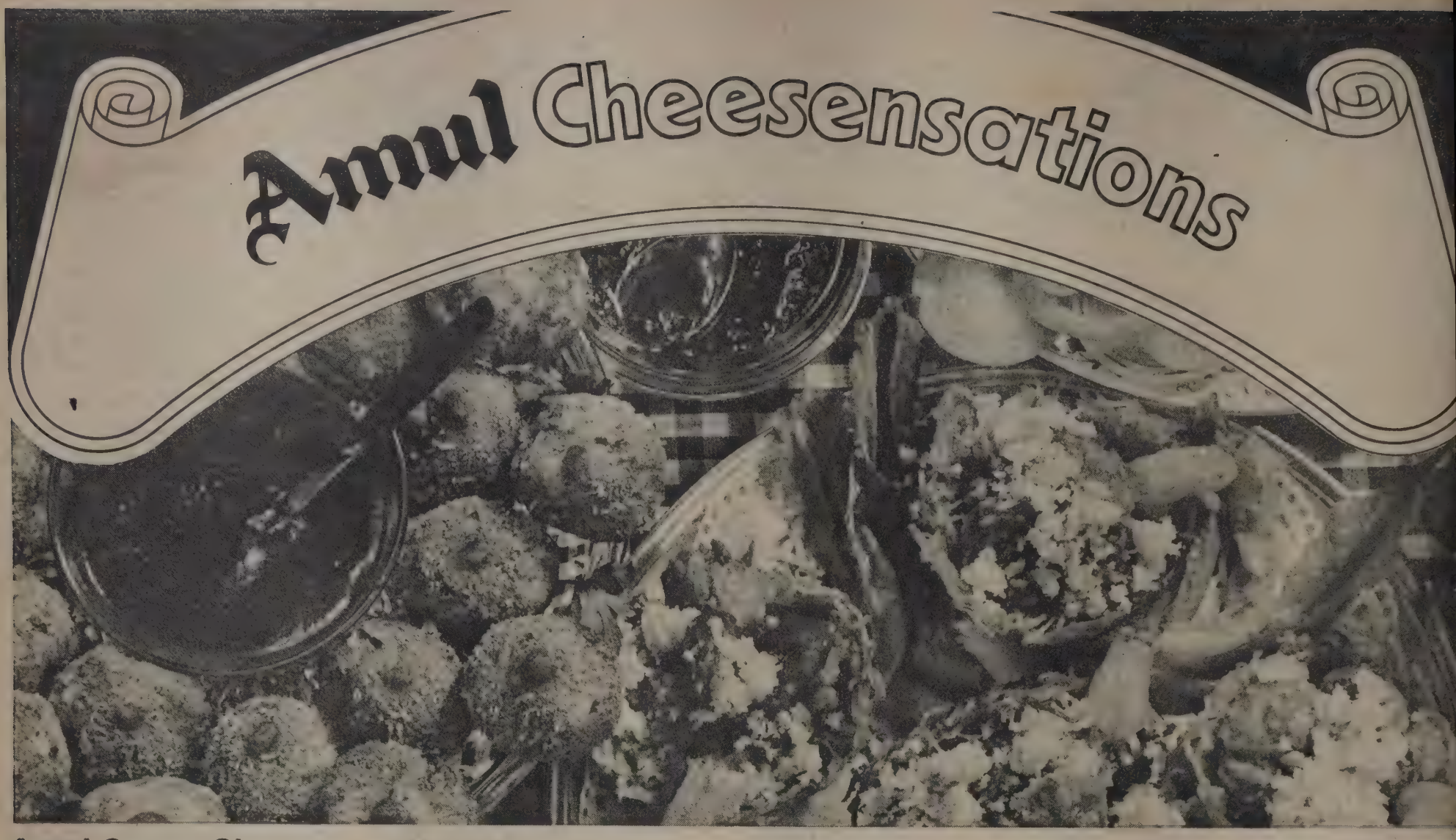
What prevents the film from shrinking down to a point? This is where the air trapped inside the bubble plays a role. Note that the air cannot escape. Therefore, as the soap film contracts, the air gets squeezed down and its pressure increases until it can balance the combined pressure of the surface and the air outside. At this point, 'stable equilibrium' is reached and the bubble has a definite volume V which is fixed by the air pressure inside. The bubble cannot get any smaller.

Any further shrinking of the soap film can only be accomplished by adjustment in shape. Indeed the surface film will naturally tend to shrink to the smallest area which can enclose the volume V. This implies a spherical shape.

It is interesting to note how such diverse and complex forces result in such a simple shape. Not only simple forms, but also the more complicated — in fact all shapes and forms without exception — can ultimately be understood in these terms.

VIVEK MONTEIRO

Amul Cheesensations



Amul Cream Cheese Capers

4 slices of fresh bread, edges removed • 1 spring onion
½ capsicum, minced
½ cup celery, chopped
1 medium tomato, blanched and chopped • Parsley
1 cup thick curds
200 gm Amul Cheese Powder
Salt and pepper

Butter bread sparingly, cut each slice into quarters. Tie freshly-set curds in a muslin cloth. Allow whey to drain out, about two hours. Whip well. Thin with a tablespoon of milk if required. Mix in spring onion, capsicum, celery, tomato, salt and pepper, Cheese Powder and fresh parsley. Spread thickly on bread squares. It can be used as a dip by thinning it with milk to the desired consistency.

Amul Cheese Prawn Baskets

For the basket

4 medium-sized potatoes • Salt
1 tsp cornflour • Fat for frying

Grate potatoes fine. Add cornflour and salt. Mix together. Take a tea-strainer and spread a little of the mixture in cup or strainer as a thin layer.

Deep fry (along with the strainer) pressing the layer with the help of a spoon. When golden brown, detach the basket and drain excess oil on a paper. Make more of these baskets and keep aside.

Filling

1 cup prawns • 1 large onion
6-8 cloves garlic } ground to a
Ginger, 1 cm piece } paste
2 medium-sized tomatoes
½ tsp garam masala
Few sprigs of coriander leaves
3 tbsp oil • Salt • Tomato sauce
100 gm Amul Cheese Powder

Heat oil and fry onions, ginger and garlic till golden brown. Cut tomatoes in small pieces and add to onions. Cook till pulp. Add prawns, salt to taste and cook till the prawns are done, sprinkling a little water if required. Add garam masala and coriander leaves. Mix well. Keep aside.

Arrange the baskets in a tray. Fill each of them with an appropriate amount of the filling. Top with a teaspoon of tomato sauce and Cheese Powder.

Amul Cheese Rice Balls

100 gm rice
150 gm Amul Cheese Powder
½ onion, finely chopped
Coriander leaves • 1 egg
Breadcrumbs for coating

Seasoning

½ level tsp mustard powder
¼ tsp red chilli powder • Salt

Add Cheese Powder into cooked rice. Add chopped onion, coriander leaves, salt, seasoning. Mix thoroughly and then mash with palm. Make round balls, then dip into beaten egg, mixed with two teaspoons of water. Coat with breadcrumbs and fry.

Amul Cheese Chines Samosas

1 cup maida • Tomato sauce
100 gm fresh boiled peas
100 gm grated Amul Cheese
Garam masala • Salt
Coriander powder • Ghee
½ tsp baking powder • Red chilli
Green coriander leaves } ground
Ginger, small piece } togethe
Green chilli }

Put two tablespoons of melted ghee, pinch of salt and baking powder in maida. Mix well and make stiff dough.

Now put one tablespoon of ghe in karai; when warm, put in pea Cheese and all the spices including ground green chilli, ginger and green coriander leave Mix well and take karai off the fire.

Take half the dough and roll, lik chappatis. Spread half the filling on chappati evenly. Roll like a Swiss roll. Cut into six pieces with a sharp knife. Repeat with the rest. Deep-fry pieces in ghee on mild heat till brown. Serve hot with tomato sauce.

CHEESE NUTRITION

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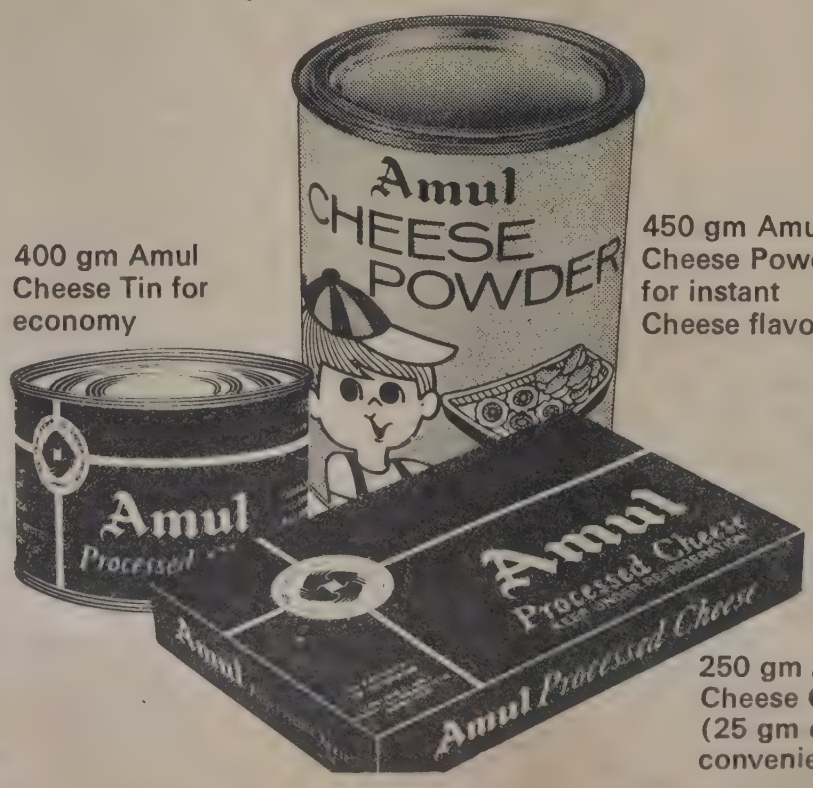

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QUESTION & ANSWER

yclones are an annual feature in the Bay of Bengal during October-ovember. The people living along the eastern sea coast of India have arnt to live with them. What they haven't learnt to live with — and no man erhaps ever will — are the giant tidal waves (the term actually is a isnomer) that inundate vast tracts of land in a mighty killing sweep. It had appened in East Pakistan in 1970. In November this year, it happened in ndhra. What lies behind these monsters thrown up by the sea? Here are ome of the answers . . .

What are 'tidal' waves?

'Tidal' waves are extra large waves that occur from time to time n different parts of the world, usually with destructive consequences. Despite heir name, however, most of these waves have nothing to do with tides. Tides, caused by the non-uniformity in he Moon's and the Sun's gravitational ttraction on the oceans, do produce a ise and fall of water level once every 2 hours. And such changes in the verall level of coastal waters do esult in waves, but these (the real *dal* waves) are at most of medium ze, about two to three metres high.

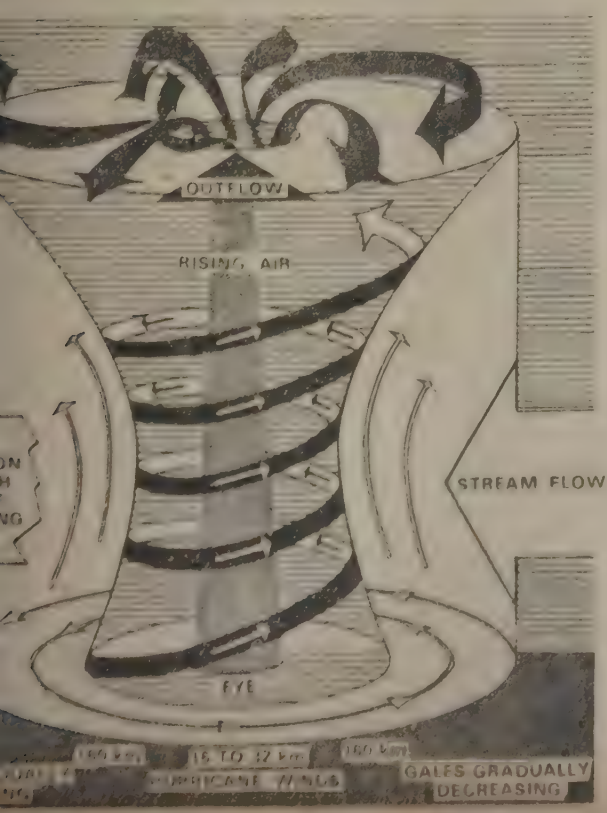
The extra-large waves which evastated Andhra Pradesh in November were caused by the high elocity winds of a cyclone but huge waves are also produced by undersea arthquakes, volcanoes and, in more ecent years, by underwater nuclear xplosions.

How large can these waves get?

Unbelievably high. The highest waves which attacked East Pakistan even years back in November 1970 were about nine metres high — about he height of a three-storey building. Tsunamis — the waves caused by underwater earthquakes or volcanoes — end to be the largest. On the average, about once every 300 years or so, a sunami over 30 metres high ravages he coast of Japan. Lesser tsunamis, rom eight to 10 metres in height, are more common, occurring once every 15 years on the average. On 27 August 1883, the town of Merak in Indonesia was completely destroyed by waves 30 to 35 metres in height which were caused by a gigantic volcanic eruption at Krakatoa, only 50 kilometres away. Sometimes waves of truly monstrous dimensions can arise locally from large waves of lesser height, for example, when a tsunami wave gets trapped in a narrow V-shaped inlet. Such secondary 'enhancement' is believed to have been responsible for the gigantic waves that demolished a radio tower at Scotch Cap, Alaska, in 1946. The foundation of the tower was 31 metres above the sea.

Though the largest waves are usually due to seismic phenomena, storm winds can whip up waves to match the biggest. In 1933, in the Pacific Ocean, waves 33 metres high were measured from aboard the *USS Ramapo*, a US Navy tanker, during a lengthy storm.

Fig. 1 The structure of a cyclone



What was the source of the destructive energy of the Andhra waves?

The Andhra 'tidal' waves were produced by storm winds. Where did the winds get their energy? The reader will remember that for several weeks prior to the November cyclones, an oppressive 'October heat' prevailed all over the Indian subcontinent. This, most likely, was the main source of the cyclone's fury.

The Sun's radiation is not particularly intense anywhere on the Earth. But its relentless and persistent action can have drastic consequences. A series of intermediary mechanisms transform the heat energy into air motion to produce a cyclone which represents a concentration, in space and time, of energy from the Sun. Energy accumulated over weeks and months is expended over a few days; energy collected over a whole hemisphere pours into a localised region like a corner of the Bay of Bengal.

How does the Sun's energy get converted into a cyclone?

Hurricanes always begin at sea within 20° of the equator. Here, in the heat of the tropical Sun, enormous quantities of water are continually being evaporated from the surface of the sea to form a deep layer of warm moist air. The Sun's action also leads to differences in the atmospheric pressure which keep increasing in time until a critical point is reached, and the air from different high pressure areas starts rushing towards the centre of low pressure. The spin of the Earth now leads to a deflection of the winds in such a manner that they begin to spiral inwards into the centre, anti-clockwise in the northern hemisphere, and clockwise in the southern hemisphere. Near the centre, the air funnels upwards like a pillar from the sea. As the air rises, it expands and cools, which leads to the condensation of water vapour to form thousands of tons of rain.

Now, just as evaporation requires heat, condensation releases this stored-up heat — which feeding back into the air renders the updraught even more intense. Whirling faster and faster, the storm officially becomes a hurricane at wind speeds above 120 kmph. Up to anything like 500 km across, the cyclone moves along the sea surface like a spinning top at maybe 30 kmph.

The rising air at the centre subsequently reaches layers where the horizontal pressure forces are much weaker, whereupon the air spirals outwards at high altitudes.

How are giant waves caused by storm winds?

How wind can cause waves should be familiar to anyone who has cooled tea. And why larger waves are caused by stronger winds, should also require no explanation. But there is a little more to it.

A turbulent breeze blowing over the sea's surface gives rise to a whole family of waves moving in the direction of the wind. These waves have different wavelengths. As the wind blows on, it continues to transfer energy to the waves already created (together with creating new waves), and thus the waves increase in height.

Normally a wave is a very stable object, which can travel long distances without losing its energy, particularly if it is long and straight. But if a water wave becomes too tall relative to its wavelength, it breaks and gives up its energy to the water around it. The breaking point comes when the angle at the crest of the wave is 120°, or when the height of the wave is about one-seventh of its wavelength (see SCIENCE TODAY, November 1977,

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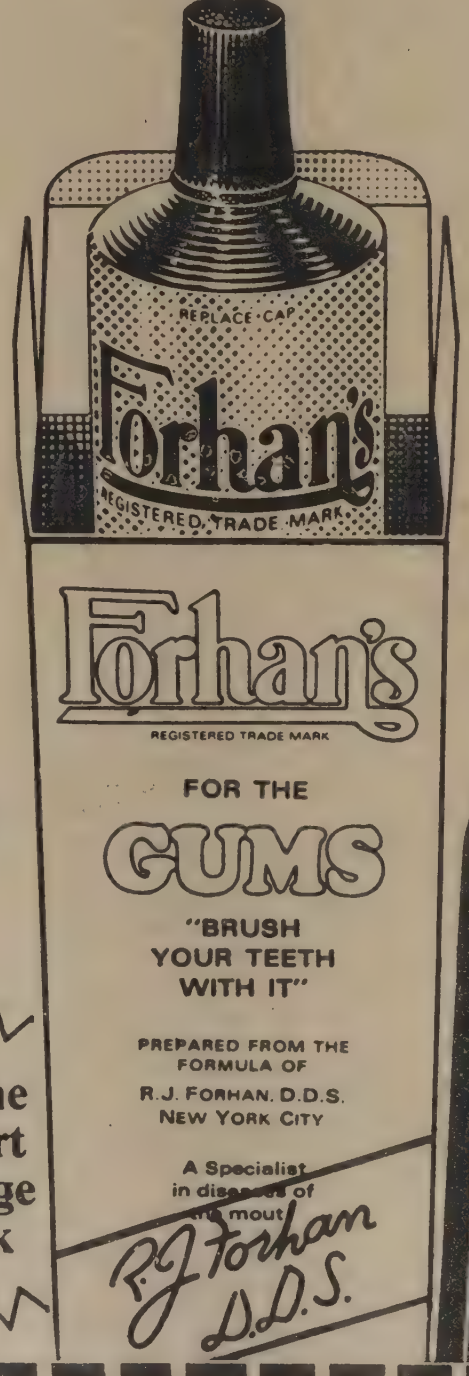
(Photostats of these and other such letters can be seen at any office of Geoffrey Manners & Co. Ltd.)



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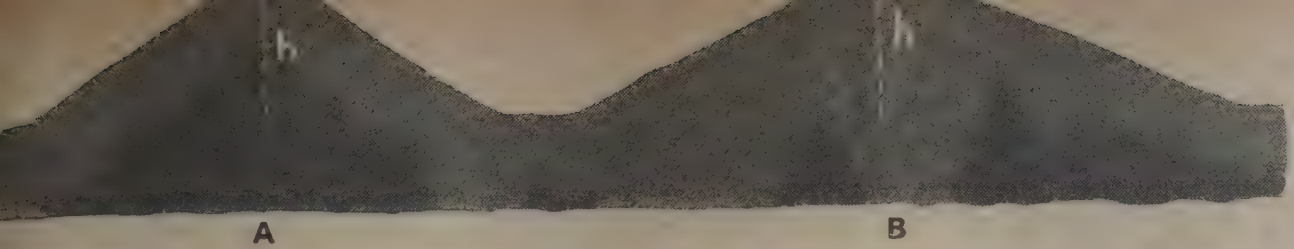


A B

g. 2 (A) A wave will break when its height exceeds about 1/7 of its wavelength and the angle the top is 120°. (B) A longer wavelength wave of the same height is stable because the angle the top is larger than 120°

p. 62). So the continuing action of ie wind leads to increase in wave eight, and thence to the elimination the small wavelength waves which come too tall. They 'slap' their nergy into the longer wavelengths. hus a 'selection' mechanism comes to play, which results in the long avelength waves 'feeding' on the aves of short wavelength.

The process goes on: the wind ntinuously puts energy into the ater, until only the very long wave-ngth waves effectively remain, and ese can rise to large heights without coming unstable. They can also avel long distances, sometimes hun-reds of kilometres outside the storm gion, carrying their fearsome energy ith them, virtually without loss, until ey encounter the land mass.

hat caused the 'fire' seen on the rface of the Andhra tidal wave?

Reports of such sightings are yet to e verified. However, similar lumines-nt phenomena have been noted in pan after tsunamis and were said to e due to the churning up of a vast umber of bottom-dwelling lumines-nt organisms by the turbulence of ie sea.

an tidal waves be prevented?

Not unless cyclones and earthquakes an be prevented, and this is still a istant goal. But they can be predicted, r at least detected, in advance of heir arrival at a coastline. Several oastal areas around the world are ow covered by a warning system omprising radar networks supple-mented with observations from specially equipped aircraft and ships. Weather satellites have added a powerful tool to the detection system. The final link of the chain is the most important — effective ways must be found to quickly and widely propagate news of an approaching cyclone or a 'tidal wave,' and then to mobilise the endangered population for protection of life and resources. In the case of the Andhra tragedy this was, apparently, the weakest link.

VIVEK MONTEIRO

Fig. 3 Satellite photo of the killer cyclone in the Bay of Bengal as it crossed the Andhra Coast on the evening of 19 November 1977. On the left another cyclone is visible over the Arabian Sea

BRAIN TEASERS

CHANGE OF JOB: In Hindu mythology, Kubera, the Lord of Wealth was eigning in the north. South was the lomain of the Lord of Death, Yama. Varuna and Indra were in the west and he east, respectively, with the overordships of the Seas and the Rains.

Once all of them went to Lord Vishnu nd each asked for a change of profession s well as place. Lord Vishnu obliged. He ven changed the professions with respect o the places. Then Varuna became the ew God of Death. Kubera was transferred o the west. The new Lord of the Seas vas stationed in the south. Who got what, nd where?

V. A. SHENAI

(Solution next month)

Solution to last month's Brain Teaser

Mix-up

The four students were correct about 1, 2, 3 and 5 ('4' correct means '5' correct also). Of these students, III and IV have A, B and E in common, which must be the correct answers. So, one of them is correct about only three and the other, about five. Now I is correct about B only and II must be correct about only two products, that is, C and D, since his E, A and B are wrong. So III was correct about all the products.

IN LIGHTER MOMENTS

Perhaps because he wanted to demonstrate a deep sense of frustration and discontentment, Charles Babbage, who developed the forerunner of modern computers, often pretended to be sullen. Once he is reported to have said, "I have invented a plan by which all fires can be effectually stopped." He added, "I shan't publish it — damn them all (Londoners), let all their houses be burnt!"

Once in some city of Italy he saw a water tap on the roadside. An inscription on the tap said, "The owner has erected the pump for the love of God and his country, that tired wayfarers might drink." And since Babbage "hated patriotism more than piety", he examined the tap a little more closely, which resulted in the discovery that "every time a wayfarer pumped some water for himself, he pumped a larger quantity into the owner's house".

* * *

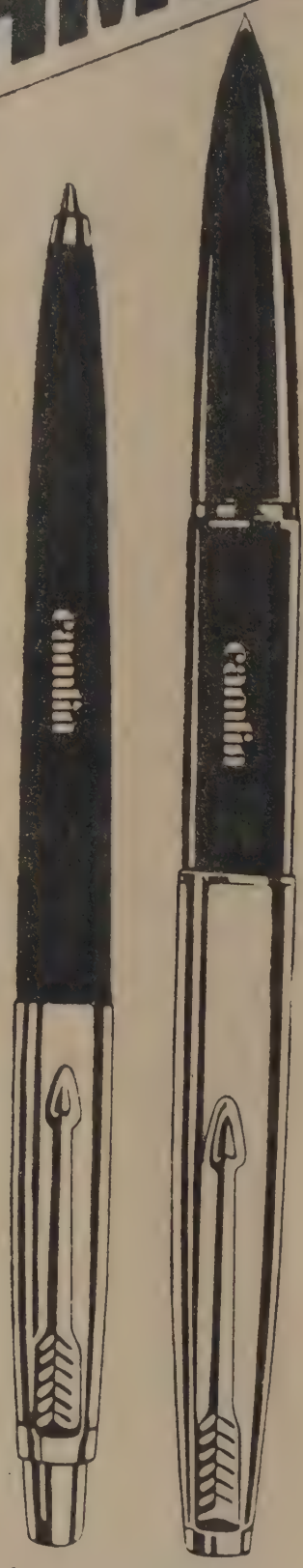
Karl Marx once asked Darwin if he could dedicate his *Das Kapital* to the author of *The Origin of Species,* Darwin rejected the request from the godless materialist, not because he had any particular objection to the book's contents but because he feared "its anti-religious views might cause concern to certain members of his own family". On the other hand, in response to his friend John Jenner Weir's proposal, he agreed to become the patron of a cat show but warned him that "people may refuse to go and admire a lot of atheistic cats".

* * *

James Price (1752-1783) was, in the words of Robert Chambers, "the last English alchemist." Price had a well-equipped laboratory where he used to make experiments in transmuting base metal to gold, and a paper on these was also published. Several eminent personalities, and chemists, too, were alleged to have personally witnessed him producing gold, some of which was presented to King George III also. On the basis of such 'authentic' evidence, Price became a member of the Royal Society. But this membership enjoined on him to reveal the formula of the powder as well as to perform transmutation in the presence of Society members. This he tried to avoid and advanced all sorts of excuses. Then, the president of the Society, Sir Joseph Banks, himself an active scientist, pressurised him and Price had to agree to demonstrate. Three scientists waited in a reception hall, as Price completed his preparations in a side-room he used as his lab. There he distilled some prussic acid and wrote down his will as well as a declaration of his intention to kill himself. Then he came out with a glass of prussic acid, greeted the scientists, hastily gulped down the deadly liquid in his hand and died on the spot.

S. N. MUNSHI

STAR PERFORMERS



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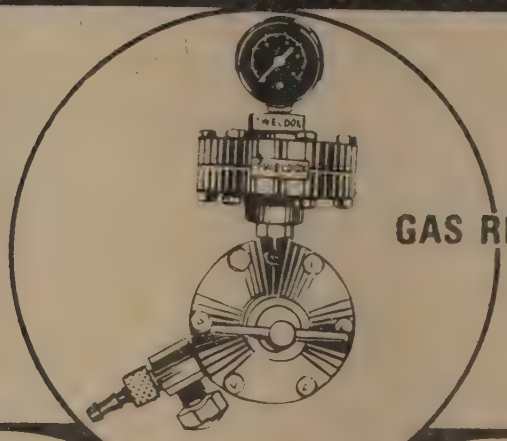

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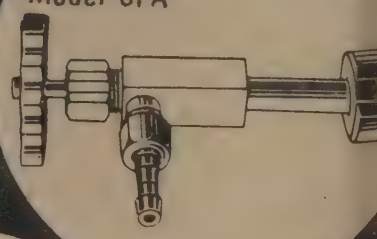

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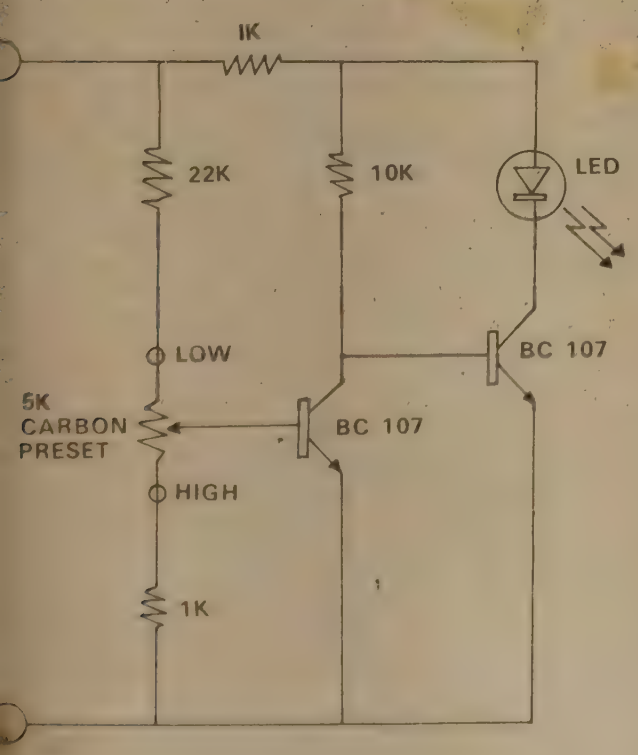
LED UNDER-VOLTAGE INDICATOR

THE LED (light-emitting diode) under-voltage indicator described below is very useful for electrical or electronic appliances working on dry cells, or accumulator batteries in motor cars and motor cycles. While the appliance is in use, and the voltage falls below a pre-set level, the LED will light up, indicating that the battery needs replacements. The under-voltage indication level can be pre-set anywhere between 3 to 18 V DC. This range covers almost all domestic, dry cell operated appliances as well as automobile batteries. When the battery voltage is more than the pre-set under-voltage level of the device, the LED remains "off" and the indicator draws negligible (about 2 to 3 mA) current from the battery. When the voltage falls below the pre-set level, the indicator switches on the LED. The LED remains lighted for any voltage between 2 volts and the pre-set under-voltage level. When the LED is lighted, the current drawn by the indicator unit depends upon the pre-set under-voltage level. For pre-set under-voltage levels from 3 to 18 V the current varies from 1 to 15 mA, respectively. The LED under-voltage indicator described below requires very few components and can be constructed on a PCB of 2·5 × 2·5 cm.



The circuit consists of a voltage divider with a pre-set potentiometer coupled to a two-stage directly coupled transistorised amplifier. The voltage provided by the pre-set potentiometer to the base-emitter circuit of the first transistor depends upon the potentiometer setting and the applied voltage. If this voltage is more than 0·6 volts, then it can provide the forward bias and the transistor comes into conduction. As the base-emitter circuit of the second transistor is connected directly across the collector-emitter of the first transistor, which is in conduction, the second transistor remains non-conductive and the LED remains OFF. When the voltage falls, the pre-set potentiometer cannot provide sufficient bias and the first transistor cannot remain in conduction. The second transistor thus comes into full conduction and the LED lights. The 1K resistor, in positive path, is for limiting the maximum current through the LED.

When you want to do the pre-set adjustment for a particular under-voltage indication, between 3 to 18 V, then apply the exact voltage and adjust the pre-set such that the LED just lights up.

Don't connect the unit directly across the battery cells of an appliance as it may draw current continuously. Connect it after the on/off switch so that the unit will light up when the appliance is switched on. In this way, while using the appliance, the lighted LED will indicate that the battery cells need replacement/recharging.

You will need:

Semiconductors : LED, 1 No. ; BC 107, 2 Nos

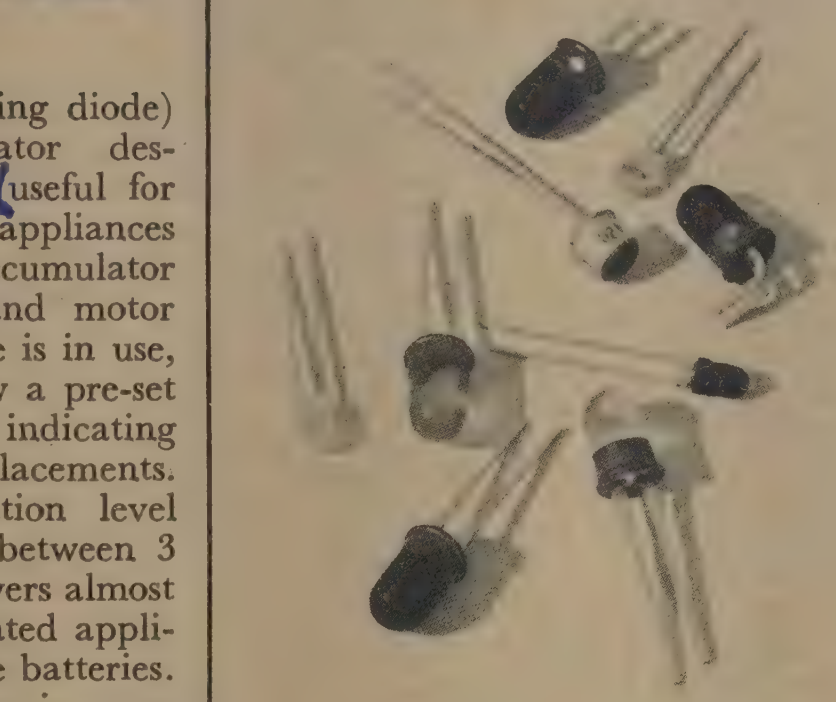
Resistors : (all half-watt) : 1 K, 2 Nos, 22 K, 1 No.; 10 K, 1 No.

Pre-set : carbon linear, 4.7 K or 5 K, 1 No.

(Cost of electronic components Rs. 20/- approx.)

Misc : PCB or veroboard, wires, screws, solder, etc.

ANIL V. BORKAR

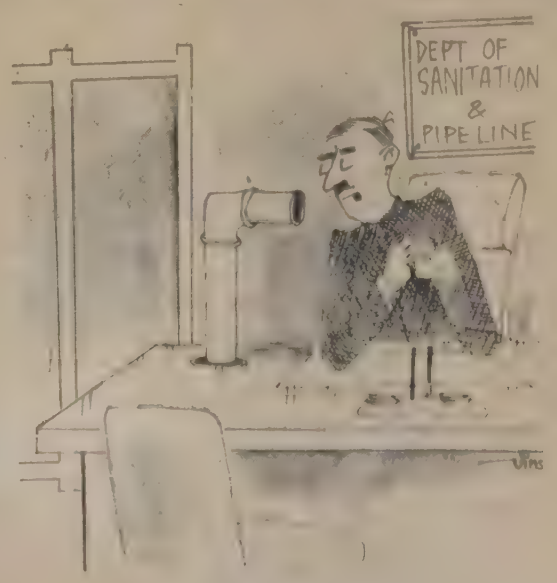


LIGHT-EMITTING DIODES (LEDs)

LEDs are superior to conventional incandescent and other types of lamps in various ways. They work on low voltage and current, and thus consume less power; require no warm-up time, no heating, and are very fast in action; emit monochromatic light; are available in red, orange and green colours (infra-red LEDs are also available); are small and light in weight; are not affected by vibrations; are less fragile than glass and have an extremely long working life.

The electrical characteristics of the LED are similar to that of the conventional semiconductor diode. Because of the rectifier action, it can carry the current only in one direction. The forward voltage of about 2 V with 5 to 10 mA current is sufficient to light a LED.

As in any semiconductor diode, with forward biasing voltage, electrons and holes will be transferred through the PN junction. During this transfer, some recombination of these carriers, that is, electrons and holes, will take place. When this recombination occurs, with conventional semiconductor diodes of either germanium or silicon, there will be release of energy which will primarily appear as heat in the diode structure. With the diodes of gallium-based semiconductor material, the energy release, because of the recombination, will be in the form of light radiation, with the wave-length related to the difference in energy levels between the junction. LEDs having three different visible light colours, viz., red, green and orange are manufactured, using basic gallium material as gallium arsenide phosphide (Ga As P) and gallium phosphide (Ga P). Infra-red LEDs are manufactured using gallium arsenide (Ga As). The infra-red LEDs are useful in conjunction with photo-diodes; they are not of any use in the construction of this device as they don't provide any visible light output.



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CA 723CT	Voltage regulator	Series, shunt or switching voltage regulators, high voltage and variable voltage power supplies
CA 741 CT CA 741 T	General purpose operational amplifiers	Instrumentation and control, signal processing, function generation and active filters
CA 3065	TV sound IF sub-system	Sound IF amplifier-limiter-FM detector-electronic attenuator and audio driver for TV receivers
CA 3068	TV Video IF sub-system	High gain IF amplifier-video detector-video amplifier-impulse noise limiter-keyed and delayed AGC-buffered AFT output, sound IF intercarrier amplifier for TV receivers
BEL 550	Voltage Stabiliser	TV tuners and high voltage power supplies
CA 3020 CA 3020 A	Multipurpose wide-band power amplifier	Audio amplifiers and inter-coms
CA 3028 A	Differential/ Cascode amplifier	Wide band RF amplifiers
3N 200 3N 187	Dual gate MOSFETS	RF amplifier, mixer in TV receivers, and in professional communicat equipments
DIGITAL :		
BEL 7400	Quad 2-input NAND gate	Computers, digital data processing, and instrumen ation and control
BEL 7410	Triple 3-input NAND gate	
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AWARDS & APPOINTMENTS

Metallurgists award

Eight metallurgists have been given the dian Institute of Metals Metallurgists Day vards. They are: Dr. Amit Chatterjee, ssistant Director (R&D), Tata Iron and eel Company, Jamshedpur, Dr. S. Chauuri, Assistant Superintendent in-charge, pen Hearth Furnace, Rourkela, Dr. R. ishnan, Metallurgy Division, Bhabha omic Research Centre, Trombay, Dr. S. Tare, Reader in Process Metallurgy, naras Hindu University, Banaras, Mr. anti Ram Das, Superintendent, Bokaro eel Ltd, Mr. Brijlal Kahatriya, Manager, ate Mill, Rourkela Steel Plant, Mr. bindranath Misra, Chief Chemist, ndustan Copper Ltd, Ghatsila, and Mr. N. Sharma, Project Manager, Magnesium ant, National Metallurgical Laboratory, mshedpur.

The awards are donated by the Union inistry of Steel and Mines.

brewala honoured

Dr. N. S. Tibrewala, a paediatrician from mbay, has been honoured by the ternational Paediatric Association, with award of a medallion. Dr. Tibrewala, esident of the XV International Congress Paediatricians held at Delhi a few nths ago, was till recently Director of Paediatrics, Topiwala National Medical College and BYL Nair Hospital, Bombay.

Rafi Ahmad Kidwai awards

Twenty-two scientists have been awarded the Rafi Ahmad Kidwai Memorial Prizes for the biennium 1974-75 by the Indian Council of Agricultural Research, New Delhi, for outstanding work in agricultural and allied sciences. The awards are given biennially and carry Rs. 10,000 each. The awardees are:

Dr. R. N. Mathur and Dr. Ishwar Prakash, Central Arid Zone Research Institute, Jodhpur, in agricultural entomology and zoology, respectively; Dr. J. J. Chinoy, Professor of Botany, University School of Sciences, Gujarat University, Ahmedabad, and Dr. B. C. Kundu, in plant physiology and agricultural botany, respectively; Dr. B. Choudhury, Indian Agricultural Research Institute (IARI), New Delhi, in horticulture; Dr. N. Ganga Prasad Rao, IARI Project Co-ordinator (Sorghum), Hyderabad, for plant breeding and genetics; Mr. E. S. Nambudri, Mr. N. Krishnamurthy, Dr. A. C. Mathew, Dr. Y. S. Lewis, and Mr. C. P. Natarajan, Central Food Technological Research Institute, Mysore, in food technology; Dr. B. Ramamoorthy, Emeritus Scientist, IARI, and Dr. N. S. Randhawa, special Director of Research, Punjab Agricultural University, Ludhiana, in soil science; Dr. M. S. Naik, Head of the Division of Biochemistry, IARI, in biochemistry; Dr. Rajendra Prasad, Professor of Agronomy, IARI, in agronomy; Mr. A. P. Bhatnagar, Professor, Processing and Agricultural Structures, Punjab Agricultural University, Ludhiana, and Mr. T. H. Nirmal, Project Co-ordinator, Operational Research Project, Central Institute of Agricultural Engineering, Bhopal, in agricultural engineering; Dr. R. P. S. Tyagi, Professor of Surgery and Obstetrics, and Dean of the College of Veterinary Science, Haryana Agricultural University, in veterinary surgery; Dr. S. P. Arora, Head of the Division of Dairy Cattle, Nutrition and Physiology, National Dairy Research Institute, Karnal, in animal nutrition; Dr. B. I. Sundararaj, Professor of Zoology, Delhi University, in fisheries science; and Dr. C. H. Hanumantha Rao, Director, Institute of Economic Growth, Delhi, and Dr. Prem Narain, Senior Professor, Institute of Agricultural Research Statistics, New Delhi, in agricultural economics and statistics.

Borlaug award

The Borlaug award for research in and contribution to agriculture has been awarded to Dr. J. S. Kanwar, Associate Director, International Crop Research Institute for Semi-Arid Tropics (ICRISAT), Hyderabad, and Dr. G. S. Khush, Head of the Plant Breeding Department, International Rice Research Institute, Philippines. Dr. Kanwar gets the award for his work in soil chemistry and soil fertility, particularly the reclamation of saline-alkali soils and dry farming, and Dr. Khush for breeding high-yielding varieties of rice with multiple disease and pest resistance. The award, instituted by Coromandel Fertilisers Ltd., carries a cash prize of Rs. 10,000.

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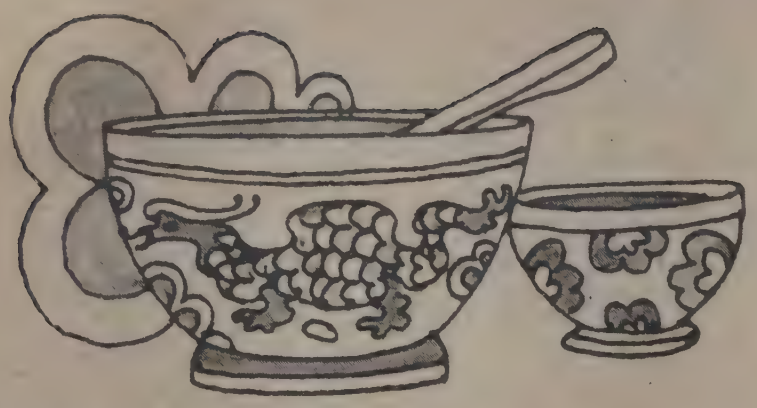

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SUNDAY STANDARD
Vijayawada, Sunday October 17, 1976

Raw Garlic is anti-bacterial

NAINI TAL Oct 29 (Samachar)

Raw garlic possesses anti-bacterial property against a number of micro-organisms including those which are resistant to commonly used anti-biotics. This is revealed in researches conducted at the Pantnagar University. According to the researchfindings, anti-bacterial property of garlic is lost on boiling.

Eve's Weekly
July - 17-1976

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NEW ODOURLESS GARLIC

THE TIMES OF INDIA
BOMBAY. DEC., 3-1976

Eat Garlic and Cut Cholestrol

NEW DELHI, December 2: A medical study has revealed that garlic is effective in reducing blood cholestrol. An experiment by Dr. R. C. Jain, pathologist at the University of Benghazi in Libya has now shown that garlic reduces the cholestrol level.

He did the experiment on rabbits which he fed with a diet containing large amounts of Cholestrol for 16 weeks. Their aorta (main blood vessel) and liver were deposited with cholestrol but after giving them garlic, he noticed that the fat dissappeared and the blood cholestrol came down. Dr. Jain has reported the results of his experiment in "The Journal of Indian Medical Research". How exactly garlic brings down cholestrol level is, however, not clear, Dr. Jain said-Samachar.

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